EPA/ROD/R03-01/545
2001

EPA Superfund
Record of Decision:

NAVAL SURFACE WARFARE CENTER - DAHLGREN
EPA ID: VA7170024684
OU 08
DAHLGREN, VA
09/28/2001

SITE 46 - JULY 28,1992
LANDFILL A, STUMP DUMP ROAD

NAVAL SURFACE WARFARE CENTER
DAHLGREN SITE
DAHLGREN, VIRGINIA

RECORD OF DECISION

SEPTEMBER 2001

NAVSEA
DAHLGREN
Surface Warfare Center Division

ENGINEERING FIELD ACTIVITY CHESAPEAKE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Site 46, July 28,1992, Landfill A, Stump Dump Road
Naval Surface Warfare Center, Dahlgren Site
Dahlgren, Virginia
CERCLIS Identification Number VASFN0302862

1.2 STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for Site 46, July 28, 1992, Landfill A, Stump Dump Road, at the Naval Surface Warfare Center Dahlgren Site (NSWCDL) in Dahlgren, Virginia. The determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this site.

The Commonwealth of Virginia concurs with the selected remedy (see Appendix A).

1.3 ASSESSMENT OF THE SITE

The response action selected in this Record of Decision (ROD) is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 DESCRIPTION OF THE SELECTED REMEDY

The Navy will manage the remediation of Site 46 as one Operable Unit which consists of the soil, groundwater, surface water, and sediments at the site. The remedial action selected in this ROD addresses protection of ecological receptors (plant and animals) from sediment contaminated with polynuclear aromatic hydrocarbon (PAH) and metals and surface water/soil contaminated with PAHs, pesticides, polychlorinated biphenyls (PCBs), and metals. The selected remedy will also minimize future migration of contaminants via surface water run-off and leaching into groundwater by removing landfill wastes and contaminated soils. There are no principal threat wastes at the site. The selected remedy, complete excavation with offsite disposal and wetlands restoration, will close Site 46 with minimal post closure care.

The major components of the selected remedy are: (1) excavation of waste and contaminated soils/sediments; and (2) site restoration.

An area of about 66,100 square feet will be excavated to remove existing landfill waste. Contaminated sediment will be excavated from an additional marsh area of approximately 21,100 square feet. Approximately 10,900 cubic yards of waste and contaminated soil/sediment will be excavated. The excavated materials will be transported to an appropriate offsite permitted landfill for final disposal.

Following excavation, the disturbed areas will be backfilled, graded, and revegetated as needed. Existing wetland areas that will be disturbed during construction will be restored as wetland areas. Along the western and southwestern boundary of Site 46, the remedial design will detail the establishment of grades, soil type, and vegetation to increase the wetland area by approximately 1.2 acres. The new wetland will approximate the elevation of the adjacent tidal wetland. Wetland hydrology and establishment will be monitored during spring and fall for the first 5 years and corrective measures will be taken as needed to replace loss of vegetation from natural causes such as drought, insects, and invasive plants.

1.5 STATUTORY DETERMINATIONS

Remedial actions must meet the statutory requirements of Section 121 of CERCLA. The selected remedy for Site 46 is protective of human health and the environment, eliminating potential present and future risks to people, plants, and animals by removing the wastes and contaminated media. The remedy complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action because removal will provide for “clean” closure of the site. Because of the heterogeneous nature of the landfill waste and contaminated soils/sediment at Site 46, the Navy concluded that it was impractical to treat these media in a cost-effective manner. The selected remedy provides overall effectiveness proportional to the cost, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. Because this remedy will not result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a 5 year review will not be required for this remedial action.

1.6 ROD DATA CERTIFICATION CHECKLIST

The following information is included in Section 2.0 (Decision Summary) of this ROD. Additional information can be found in the Administrative Record file for NSWCDL Site 46:

- Chemicals of concern (COCs) and their respective concentrations
- Baseline risk represented by the COCs
- Clean-up levels established for COCs and the basis for the levels
- The absence of principal threat wastes at the site
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected.
- Key factors that led to selecting the remedy (i.e., a description of how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision).

1.7 AUTHORIZING SIGNATURES

CAPT. Lyal B. Davidson, USN
Commander
Naval Surface Warfare Center
Dahlgren, Virginia

9/26/01
Date

Abraham Ferdas, Director
Hazardous Site Cleanup Division
U.S. EPA - Region III

9/28/01
Date

2.0 DECISION SUMMARY

This ROD is issued to describe the U.S. Department of the Navy's (Navy) and U.S. Environmental Protection Agency's (USEPA) (support agency) selected remedial action for Site 46 at the NSWCDL in Dahlgren, Virginia (Figure 2-1). The Commonwealth of Virginia (support agency) concurs with the selected remedy. The Navy is the lead agency for the project and provides funding for site clean-ups. Site 46 (Figure 2-2) is one of several Installation Restoration (IR) sites located at the NSWCDL facility, CERCLIS Site Identification Number VASFN0302862.

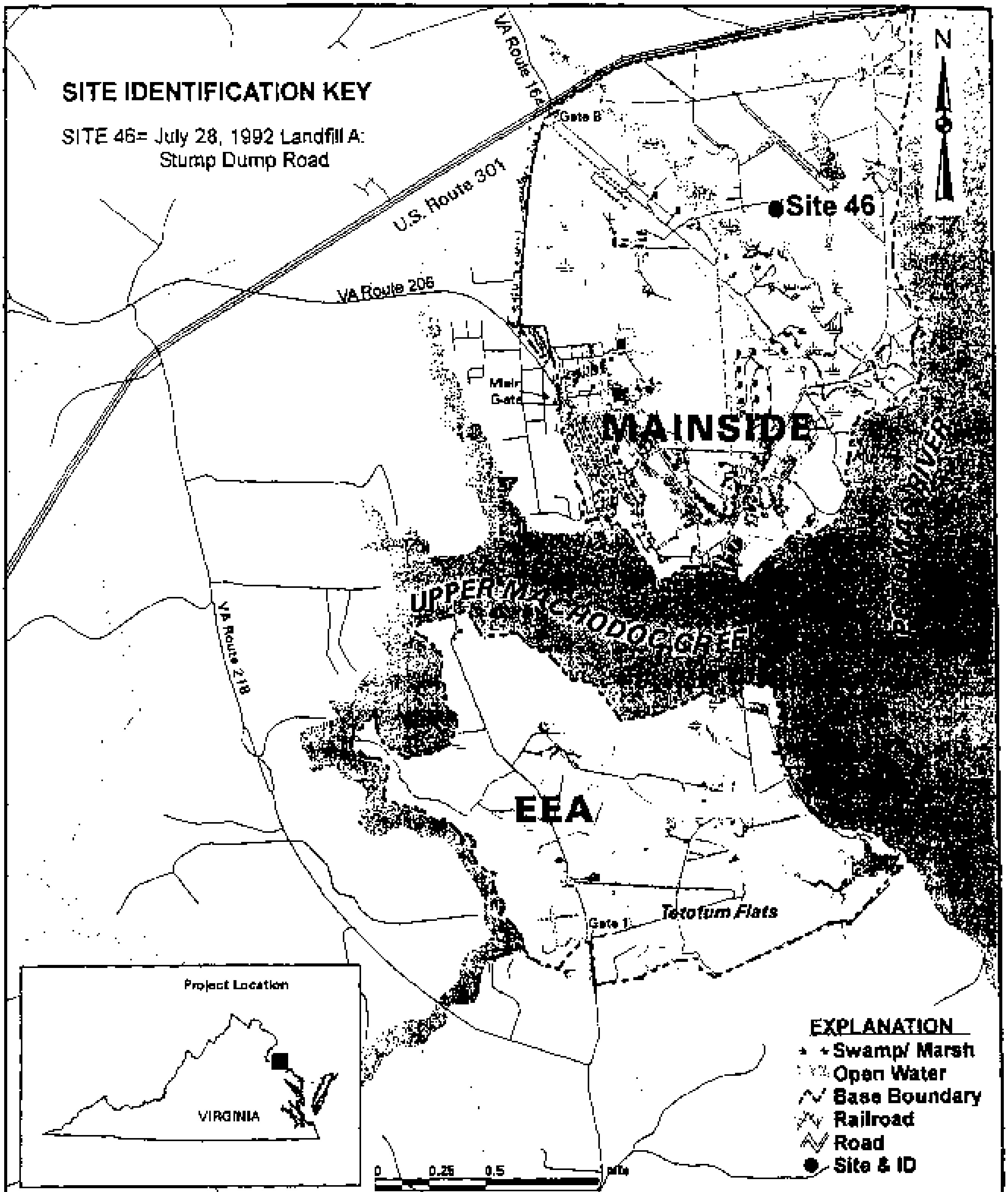
2.1 SITE NAME, LOCATION, AND DESCRIPTION

Site 46, July 28, 1992, Landfill A, Stump Dump Road, is located about 250 feet south of Stump Dump Road, adjacent to a tributary of Gambo Creek in the central part of the Mainside area of NSWCDL. Site 46 was formerly known as Solid Waste Management Unit (SWMU) 47. Land within a 0.5-mile radius of Site 46 is primarily undeveloped. The nearest residential area is approximately 1.5 miles southwest of the site. The site is within and surrounded to the north, east, and south by former ordnance impact areas. The southwest side of the landfill is approximately 350 feet in length and borders or extends into the adjacent marsh. A small drainage borders the northwest edge of the landfill. Wooded areas border the remaining sides of the landfill. Access to the site is restricted by woods and heavy undergrowth and a locked gate at the entrance to Stump Dump Road limits vehicular access to the area. The unlined fill area along the edge of the creek tributary was used from the early 1940s to the late 1960s. Wastes disposed of at Site 46 included municipal waste, electrical components, construction debris (such as roofing tar and shingles), and machine shop wastes (such as metal shavings). Railroad ties are visible along the edge of the marshy area.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.2.1 History of Site Activities

According to a USEPA study of aerial photographs, activity was first identified at Site 46 in the 1943 imagery. Evidence of ordnance impact was observed at this time and continued to be evident in the 1944 imagery. In the 1944 imagery, an access road was observed extending south of Stump Dump Road. The access road was no longer in use in 1946 and the bombing area was observed to be re-vegetating. In the 1952 imagery, a linear ground scar just south of Stump Dump Road and a new access road leading south through the area



DRAWN BY	DATE		CONTRACT NO	OWNER NO
LR	1/26/01	Tetra Tech NUS, Inc.	7316-1081	CTO 283
CHECKED BY	DATE	SITE LOCATION MAP NSWCDL DAHLGREN, VIRGINIA	APPROVED BY [signature] DATE 08-03-01	
KJC	1/26/01		APPROVED BY DATE	
COST/SCHED-AREA			DRAWING NO. Figure 2-1	REV. 0
SCALE AS SHOWN				

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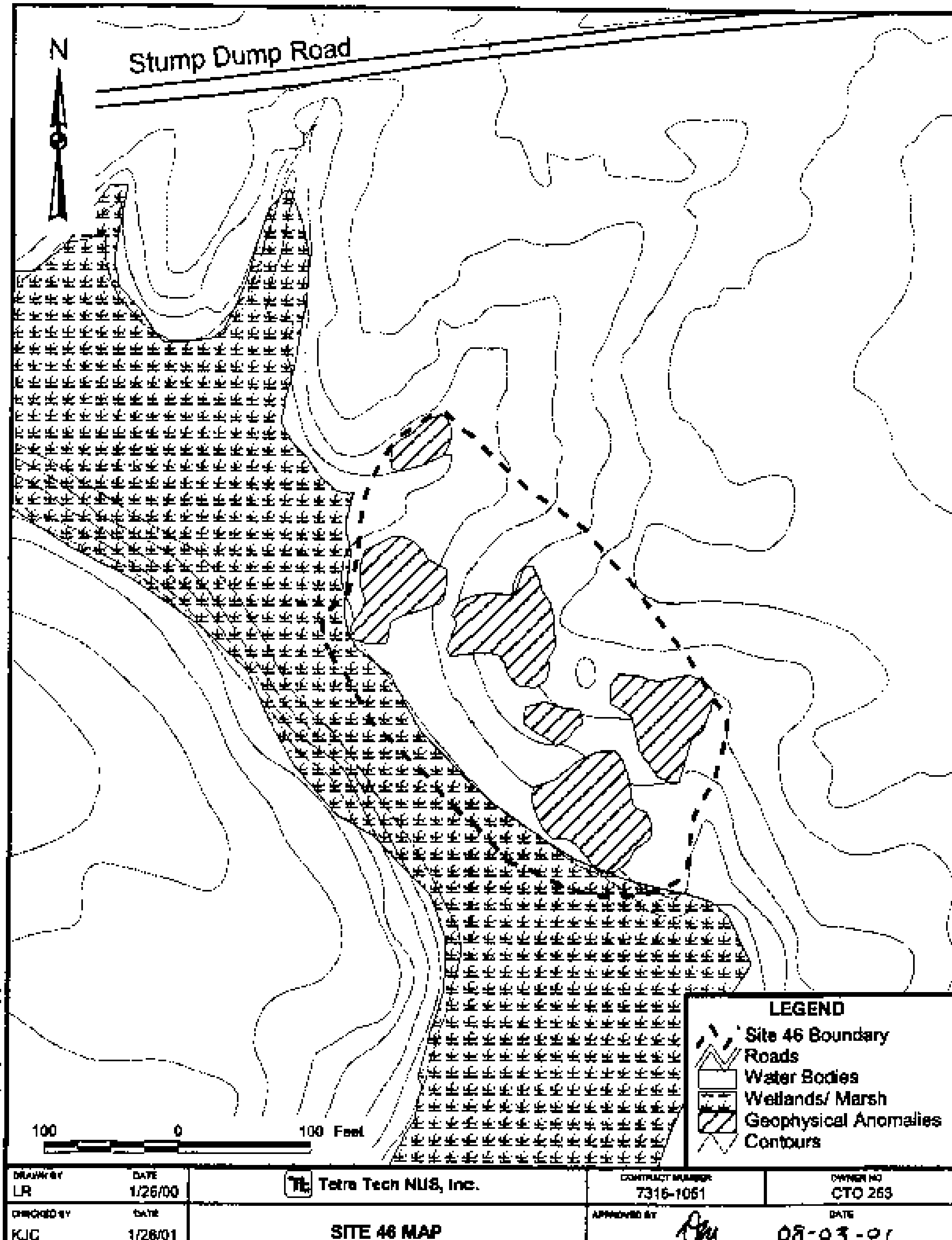


DRAWN BY: LR	DATE: 1/26/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 7316-1061 / OWNER NO: CTO 253
CHECKED BY: KJC	DATE: 1/26/01	SITE 46 MAP	APPROVED BY / DATE: 08-03-01
COST/SCHEDULE-AREA		NSWCDL	APPROVED BY / DATE
SCALE: AS NOTED		DAHLGREN, VIRGINIA	DRAWING NO: Figure 2-2 / REV: 0

k:\gproject\dahl\site 46_ri.apr (SiteMap) to a large area of disturbed ground, were observed. A linear ground scar was also apparent in the area of disturbed ground. In 1953, the ground scars and disturbed ground were re-vegetating, and the access road no longer appeared to be in use. Disposal activity at Site 46 was first observed in the 1958 imagery, which showed a large area of disturbed ground on the south side of Stump Dump Road. Evidence of fill, extending into the wetland, was apparent on the west side of the disturbed area. A rectangular area, with evidence of standing liquid, was observed adjacent to the west access road extending from Stump Dump Road in the 1960 imagery. By 1962, much of the fill area had re-vegetated. The eastern access road had been extended south and evidence of a fill area was noted off the road, in the bordering wetland. Activity in the southern portion of the site, bordering the wetland, continued to be evident until 1969. Vegetation was observed growing on the materials deposited in the wetland between 1962 and 1967. No significant changes in the site were apparent from 1967 through the 1990 imagery, with the exception of a ground scar observed in the northeastern corner of the site along Stump Dump Road.

On August 4, 1992, three 55-gallon drums of roofing tar were removed from the west side of the fill area and disposed of properly. At that time, the drums were corroded and visual evidence of leakage was noted.

Scattered debris (such as roofing shingles, empty 55-gallon drums, railroad ties, metal turnings, and miscellaneous scrap metal) was visible on the ground surface during recent field activities.

2.2.2 Previous Investigations

A Site Screening Process (SSP) investigation was performed at NSWCDL in 1994 and 1995 to provide information to support a decision to investigate further, implement a removal action, or conduct no further action at Site 46. The specific objectives of the SSP investigation were to: identify the type, location, and levels of contamination at the study site; identify the physical site-specific characteristics that may influence contaminant distribution; and determine the potential for contaminant migration.

Site 46 SSP field activities consisted of two phases. Phase I field activities were conducted in June 1994 and included a surface geophysical survey, which consisted of both magnetic and electromagnetic (EM) terrain conductivity surveys. Phase I results were used to guide Phase II activities by focusing the investigation on specific anomalies.

Phase II field activities, conducted between December 1994 and March 1995, included the following: collecting soil borings; installing monitoring wells; collecting and analyzing groundwater, surface water, sediment, and surface and subsurface soil samples; surveying monitoring wells; and collecting groundwater level measurements. The analytical data generally indicated that PAHs and inorganics were the chemicals most often found at Site 46 in concentrations exceeding screening guidelines or criteria. The SSP concluded that a Remedial Investigation/Feasibility Study (RI/FS) was needed at Site 46.

RI field activities were completed in 1997 by Tetra Tech NUS, Inc. (TtNUS) in accordance with work plans approved by the U.S. Navy, USEPA, and the Virginia Department of Environmental Quality (VDEQ). Environmentally significant compounds detected at Site 46 included metals and PAHs and, to a lesser degree, pesticides and polychlorinated biphenyls (PCBs). These chemicals were distributed randomly in the surface and subsurface soils at the site, as would be expected in a heterogeneous fill area. Contaminant migration had occurred to a minor degree into the marsh, probably as a result of soil transport through erosion or tidal action. The compounds detected in the marsh may also have resulted from direct waste deposition.

Additional FS field work was conducted in 2000 to fill data gaps identified during the Site 46 RI and to provide the necessary data to evaluate remedial alternatives in accordance with the Focused Feasibility Studies (FFSs) Priority 1 Sites Project Plans. This work included re-sampling of groundwater and surface water, as well as trenching to determine the location, nature, and volume of buried wastes present in the subsurface soils. Groundwater samples were collected from permanent monitoring wells and used to re-evaluate potential human health risks under the residential use scenario. Results from the FS samples were compared with the RI sample results to estimate a more accurate concentration of chemicals in groundwater. The FS used a new groundwater sampling methodology which more accurately measured the true contamination levels in groundwater. The RI samples were collected using an older method that may have introduced soil particles in the sample, resulting in less accurate data. Surface water samples were collected using a methodology designed to minimize the presence of suspended solids and thus provide more representative metal concentrations in the surface water than those collected during previous RI sampling.

A detailed description of site contamination is provided in Section 2.5, and includes sources, nature, extent, and migration.

An ecological assessment of Gambo Creek within the Mainside of NSWCDL was conducted from September 25 through October 13, 1995. The objectives of this assessment were to: 1) analyze contaminant concentrations in surface water and sediments at selected locations throughout Gambo Creek to determine the nature and extent of contamination; 2) evaluate the health of the animals living in the sediment such as worms and clams and the toxicity of sediment-bound contaminants; and 3) determine whether contaminants present in Gambo Creek were capable of accumulating in plants and animals. Sampling points were located along Gambo Creek and also placed downstream of Sites 2, 9, 12, 6, 45, and 46 to further assess the potential impact of these sites on the ecology of Gambo Creek. Surface water, sediment, small animals within the sediment, and fish tissue samples were collected. The results of this assessment indicated that contaminant concentrations high enough to impact plants and animals were generally restricted to localized areas in Gambo Creek near Sites 2, 9, and 12. No evidence was found for widespread contamination that would pose a significant risk to plants and animals in the creek. Phase II of the Gambo Creek Ecological Risk Assessment was initiated in October 2000 to further characterize contaminant concentrations in sediment and tissue, and to evaluate risks to marsh vegetation and wildlife, and wildlife feeding on them.

Screening level and baseline ecological risk assessments specific to Site 46 are included in the RI and FS, respectively. The baseline ecological risk assessment is described in Section 2.7.2.

2.2.3 Enforcement Actions

No enforcement actions have been taken at Site 46. The Navy has owned the property since 1918 and is identified as the responsible party.

2.3 COMMUNITY PARTICIPATION

In accordance with Sections 113 and 117 of CERCLA, the Navy provided a public comment period from July 20, 2001, through August 20, 2001, for the proposed remedial action described in the RI, FS, and the Proposed Plan for Site 46.

The RI, FS, and Proposed Plan were available to the public in the Administrative Record and at information repositories maintained at the Smoot Memorial Library, King George, Virginia; the NSWCDL General Library, Dahlgren, Virginia; and the NSWCDL Public Record Room, Dahlgren, Virginia. Public notice was provided in *The Freelance Star* on July 11 and 18, 2001. Additionally, notices were published in *The Journal, The Westmoreland News*, and *Maryland Independent* newspapers on July 18, 2001. A public meeting was held in the King George Courthouse on July 24, 2001. No comments were received during the comment period. A transcript of the public meeting is presented in Appendix B.

The Navy and NSWCDL have had a comprehensive public involvement program for several years. Starting in 1993, a Technical Review Committee (TRC) met twice a year (on average) to discuss issues related to investigative activities at NSWCDL. The TRC was primarily composed of governmental personnel; however, the meetings were open to the public and a few private citizens attended the meetings.

In the fall of 1994, the Navy converted the TRC into a Restoration Advisory Board (RAB) and eight to ten community representatives joined. The RAB is co-chaired by a Navy member and a community member and holds meetings, which are open to the public, approximately every 4 to 6 months. The RI and FS for Site 46 were discussed at the RAB meetings.

Community relations activities for the final selected remedy include:

- Placing the documents concerning the investigation and analysis at Site 46 in the information repository at the NSWCDL General Library and the Smoot Memorial Library.

- Announcing the availability of the documents and the public comment period/meeting date in *The Freelance Star* on July 11 and 18, 2001. Additionally, notices were published in *The Journal, The Westmoreland News*, and *Maryland Independent* newspapers on July 18, 2001.

- Establishing a 30-day public comment period starting July 20, 2001, and ending August 20, 2001, for review of the Proposed Remedial Action Plan.

- Holding a Public Meeting on July 24, 2001, to answer any questions concerning the Site 46 Proposed Plan.

2.4 SCOPE AND ROLE OF RESPONSE ACTIONS AT SITE 46

NSWCDL is divided into two areas: (1) Mainside, consisting of 2,677 acres; and (2) the Explosive Experimental Area, consisting of 1,614 acres. NSWCDL has 71 sites that require investigation and potential clean-up. These sites were prioritized, based on potential risk to humans and the environment. Remedies have been initiated at 11 of the top priority sites. Site 46 is one of several high priority sites, which is currently being addressed. Thirty-six of the remaining 60 sites require no further action based on risk evaluations. Investigations are ongoing or planned for the remaining sites. A list of all sites can be found in the current version of the Site Management Plan, which is located in the Administrative Record. The Site Management Plan contains the location, description, contaminants of concern, and clean-up status of each site. Site 46 is included in the Site Management Plan.

The selected remedy for Site 46 fits into the overall NSWCDL site strategy. One element of the Site 46 remedial action will be to construct additional wetlands to compensate for wetland losses experienced from remediation of Site 9.

2.5 SITE CHARACTERISTICS

2.5.1 Site Overview and Features

Site 46, July 28, 1992, Landfill A, Stump Dump Road, is an unlined landfill less than two acres in size and adjacent to a tributary of Gamba Creek in the central part of the Mainside area of NSWCDL. The landfill was used to dispose of municipal waste, electrical components, construction debris, and machine shop wastes from the early 1940s to the late 1960s. Land within a 0.5-mile radius of Site 46 is primarily undeveloped, and vehicular access to Stump Dump Road is restricted. Site 02, the Fenced Ordnance Burial Area, lies approximately 600 feet west of Site 46. Site 09, the Disposal/Burn Area, and Site 12, the Chemical Burn Area, lie about 1,000 feet to the south and 1,500 feet to the northwest, respectively. The Explosive Ordnance Disposal (EOD) facility and several magazines for ordnance storage are the only active structures within 0.5 mile of Site 46. The nearest residential area is located approximately 1.5 miles southwest of the site.

The southwest side of the landfill is approximately 350 feet in length and borders or extends into the adjacent marsh. A small drainage borders the northwest edge of the landfill. A large clearing created by a recent timber harvest lies northeast of the landfill. The remaining sides are bordered by woods. Site elevation ranges from about 2 feet above mean sea level at the edge of the marsh to about 10 feet above mean sea level on the northeast side of the landfill. The surface of the site where disposal has occurred is uneven and contains several pools of standing water. The site is generally not eroding and has a thin cover of weeds, brush, and saplings. The groundwater levels on the site are near the surface. Most rainfall runs off to the adjacent marsh. Water that ponds on site either evaporates or slowly infiltrates the ground. The marsh is a tidally influenced tributary of Gambo Creek. The source of this tributary lies northwest of the site. The tributary flows south for approximately 500 feet and joins Gambo Creek, which continues in a general southeasterly direction for about 1.6 miles before discharging to the Potomac River.

Surface soils within the boundaries of Site 46 are classified as belonging to the sand and gravel pit (Sa) series in the Soil Survey of Stafford and King George Counties, Virginia. The sand and gravel pit series consists of open excavations. Based on borehole logs developed during monitoring well installation, the site is underlain primarily by silt and clay, possibly belonging to the Tabb Formation, and recent alluvium consisting of organic-rich swamp sediments. Upgradient of the site boundary, the subsurface is characterized by a surficial silty clay layer, followed by a dry, stiff clay that is underlain by a medium-grained sand zone at approximately 12.5 feet below ground surface.

Four monitoring wells installed at Site 46 provided hydrogeologic information on the uppermost groundwater-bearing zone. This zone was present upgradient of Site 46 in a medium-grained sand layer beginning at a depth of 12 feet below ground surface. Groundwater downgradient of the landfill area, near the discharge area to the adjoining surface water body, is present within 1 to 2 feet of the surface within a clayey silt layer and underlain by peat and highly organic silt and clay. "Downgradient" locations are locations where groundwater levels are lower. "Upgradient" locations are locations where groundwater levels are higher. Groundwater tends to flow downgradient, just as stream water tends to flow downstream. Groundwater may be in direct contact with landfilled materials in this area. Groundwater flow direction across the site is generally to the southwest. An average linear flow velocity of 0.2159 feet/day was estimated for the uppermost water-bearing zone, using site-specific hydraulic conductivity and gradient.

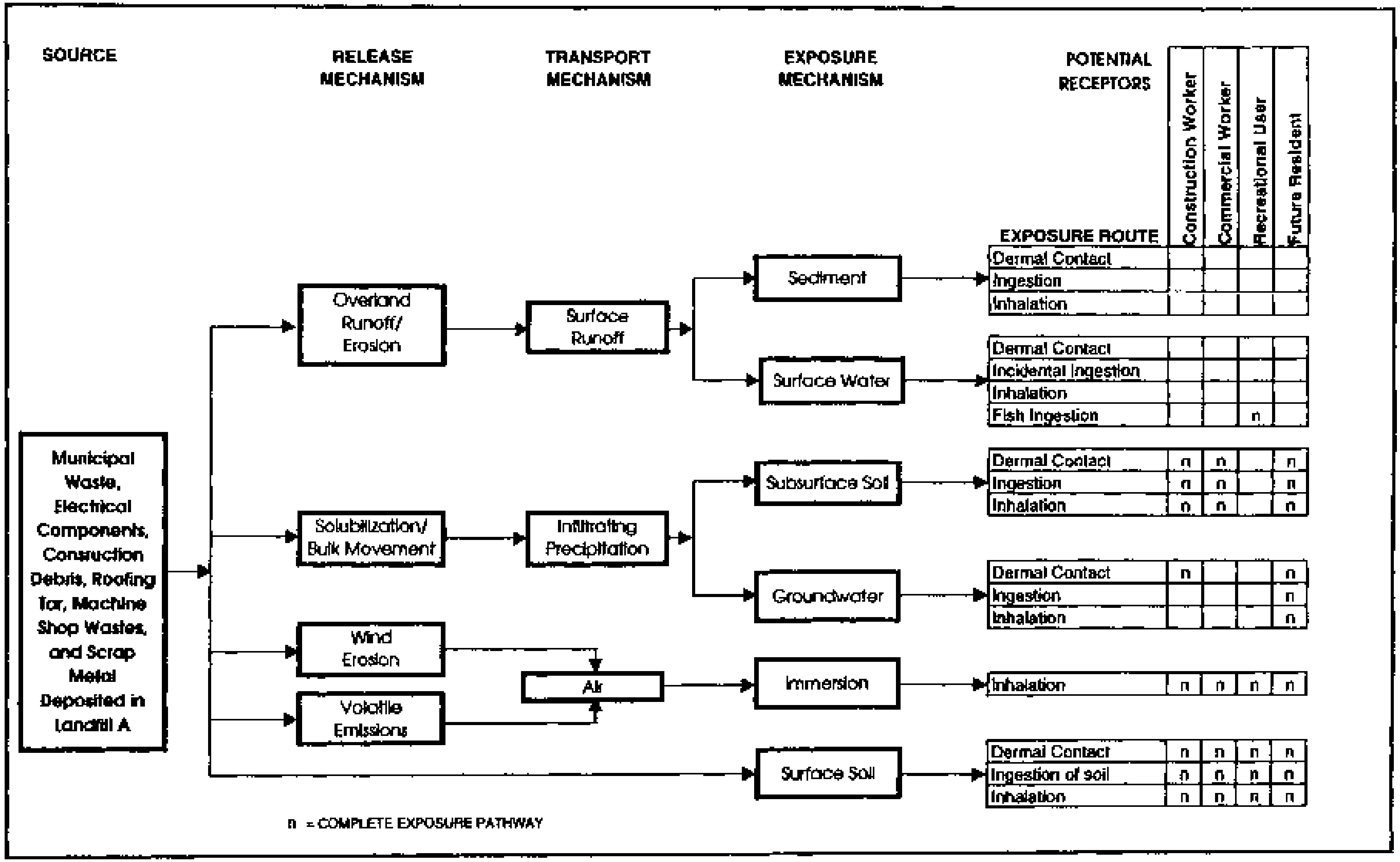
The primary productive aquifer in the vicinity of NSWCDL is the Potomac Formation. NSWCDL and Dahlgren municipal wells collect water from the Potomac Formation, approximately 600 to 800 feet below ground surface. The water supply in this aquifer originates from an area several miles upgradient of Dahlgren, where the Cretaceous sands and gravels are exposed at the surface along the Fall Line. Minimal or no recharge to the Cretaceous aquifers occurs from the surface directly downward at NSWCDL because of the 300 foot thick low-permeability Tertiary sediments, which act as confining beds.

The results of the hydrogeologic assessment conducted by USGS at the Mainside indicate the presence of at least two confined aquifers that occur between the watertable aquifer and the productive lower and middle Potomac aquifers.

The development of a conceptual site model (CSM) is an essential component of the risk assessment process. The CSM integrates information regarding the physical characteristics of the site, exposed populations, sources of contamination, and contaminant mobility (fate and transport) to identify potential exposure routes and receptors to be evaluated in the risk assessment. A well-developed CSM allows for a better understanding of the risks at a site and will aid the risk managers in the identification of the potential need for remediation. The CSM depicts the relationships among the following elements:

- Site sources of contamination
- Contaminant release mechanisms
- Transport/migration pathways
- Exposure routes
- Potential receptors

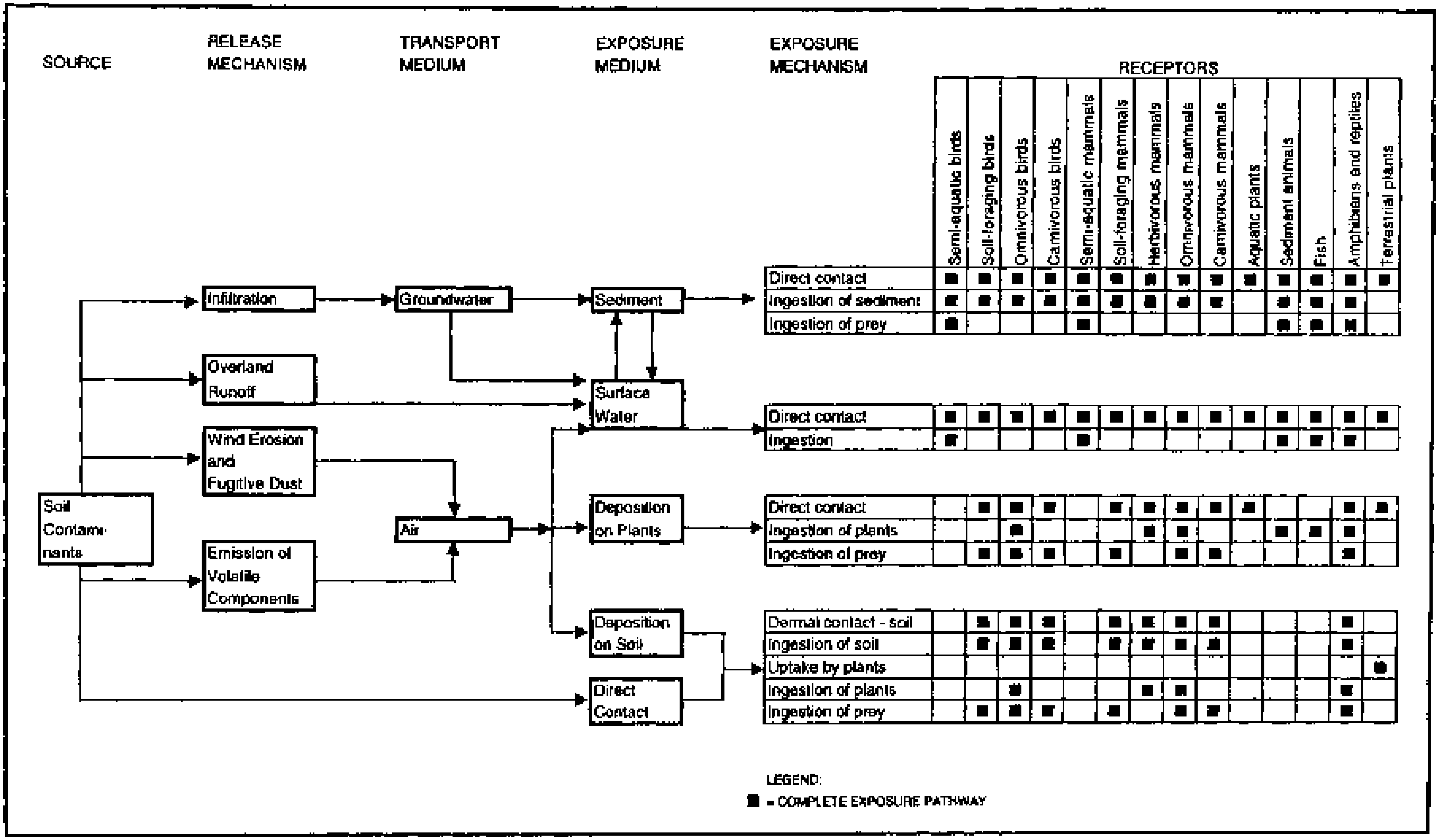
The site-specific CSM for Site 46 is illustrated in Figure 2-3 for human receptors and in Figure 2-4 for ecological receptors.



Blank space indicates incomplete exposure pathway or relatively insignificant, or not applicable potential exposure.

FIGURE 2-3

HUMAN HEALTH CONCEPTUAL SITE MODEL
SITE 46, JULY 28, 1992 LANDFILL A: STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA



Exposure Medium	Exposure Mechanism	Semi-aquatic birds	Soil-foraging birds	Omnivorous birds	Carnivorous birds	Semi-aquatic mammals	Soil-foraging mammals	Herbivorous mammals	Omnivorous mammals	Carnivorous mammals	Aquatic plants	Sediment animals	Fish	Amphibians and reptiles	Terrestrial plants
Sediment	Direct contact	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Ingestion of sediment	■	■	■	■	■	■	■	■	■		■	■	■	
	Ingestion of prey	■				■						■	■	■	
Surface Water	Direct contact	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Ingestion	■				■						■	■	■	
Deposition on Plants	Direct contact		■	■	■		■	■	■	■	■			■	■
	Ingestion of plants			■				■	■			■	■	■	
	Ingestion of prey		■	■	■		■		■	■				■	
Deposition on Soil / Direct Contact	Dermal contact - soil		■	■	■		■	■	■	■				■	
	Ingestion of soil		■	■	■		■	■	■	■				■	
	Uptake by plants														■
	Ingestion of plants			■				■	■					■	
	Ingestion of prey		■	■	■		■		■	■				■	

Blank space indicates incomplete exposure pathway of relatively insignificant, or not applicable potential exposure

FIGURE 2-4

ECOLOGICAL CONCEPTUAL SITE MODEL
SITE 46, JULY 28, 1992 LANDFILL A: STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

2.5.2 Sampling Strategy

The RI and FS at Site 46 included contamination and risk assessments. The RI field investigation was developed, based on data from the Site Screening Process, which included collecting and analyzing groundwater, surface water, sediment, and surface and subsurface soil samples for a broad range of contaminants. RI and FS field efforts focused on metals and semivolatile organic compounds (SVOCs) and, to a lesser degree, pesticides and PCBs, in these media.

2.5.3 Sources of Contamination

Based on the RI and FS sampling results, the source of contamination in environmental media at the site is believed to be the landfilled materials buried at Site 46. These materials may have released metals, PAHs, and PCBs. In addition to the historical records, source characterization was verified by observations made during the trenching in April 2000. Approximately 70 percent of the fill and waste observed during trenching was wood, tree stump, and railroad tie debris, while about 30 percent was metal debris and construction/building rubble. Strong petroleum (creosote) odor was encountered when railroad ties were excavated. Several investigative trenches ended near the marsh. Of the items described from excavations nearest the marsh, railroad ties, roofing shingles, and metal debris are the most likely to be the contaminant sources.

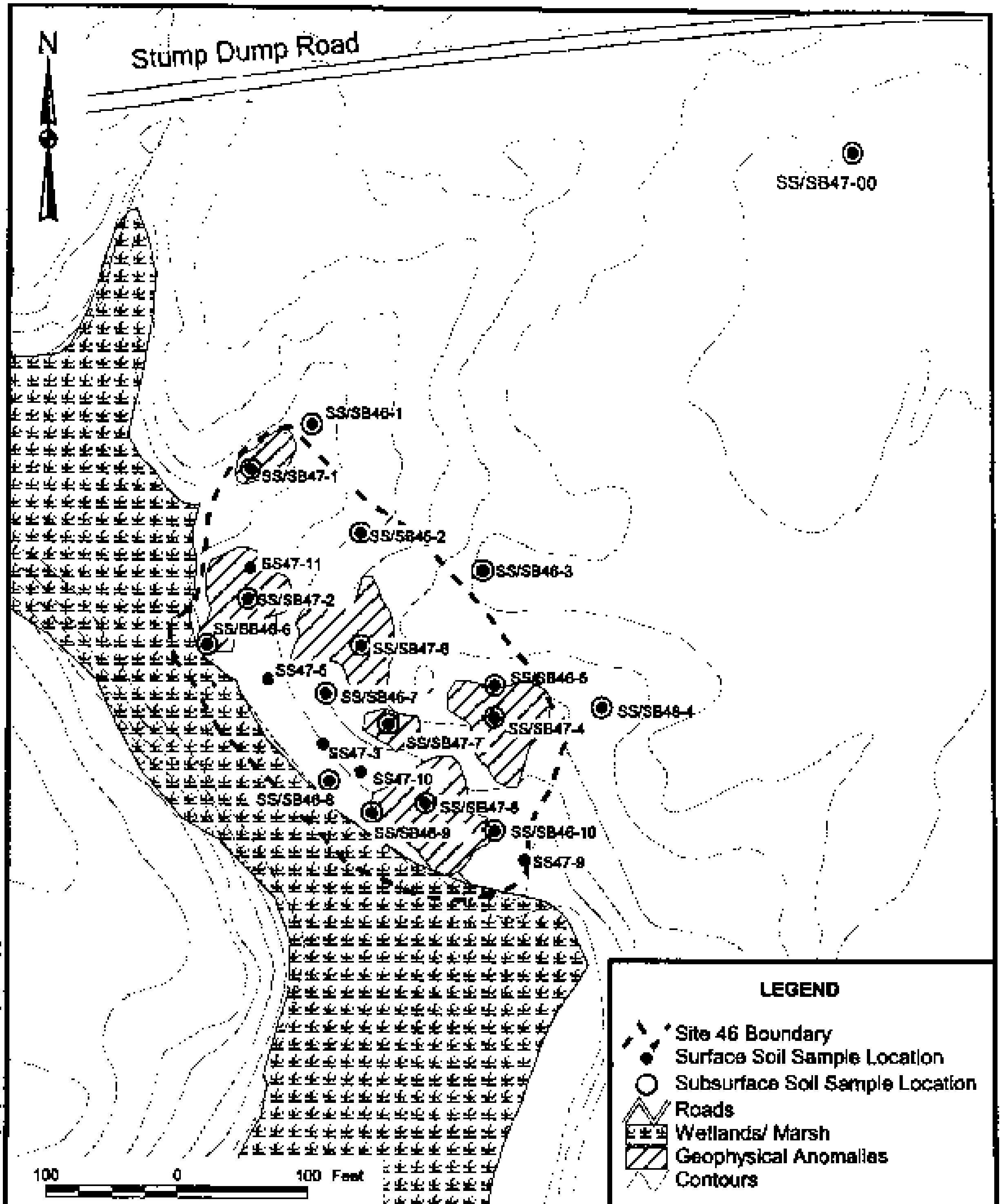
2.5.4 Description of Contamination

The following sections discuss results of the RI sampling and analysis for soils and sediments. For groundwater and surface water, both RI and FS sampling and analysis results are discussed.

2.5.4.1 Surface and Subsurface Soils

RI soil sample locations at Site 46 are shown in Figure 2-5. Summaries of the occurrence and distribution of chemicals in surface and subsurface soils are provided in Tables 2-1 and 2-2, respectively.

Twenty-one SVOCs were detected in surface soils at Site 46. These included 17 PAH compounds, two phthalates, and one each of dibenzofuran and carbazole. PAH compounds were detected in all surface soil samples (including the site-specific background samples), except SS47-1. Surface soil samples SS46-8 and SS46-9 were not analyzed for SVOCs. PCB compounds Aroclor-1254 and -1260, were detected in surface soils at Site 46. Seven pesticides were detected in the surface soils, including 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, aldrin, endosulfan II, endrin ketone, and methoxychlor.



DRAWN BY LR — DATE 10/31/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7316-1051	OWNER NO. CTO 283
CHECKED BY KL — DATE 10/31/00	RI SOIL SAMPLE LOCATIONS SITE 46 (FORMERLY SWMU 47) NSWCDL DAHLGREN, VIRGINIA	APPROVED BY	DATE 08-03-01
COST/SCHEDULE-AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. Figure 2-5	REV 0

k:\gproject\dahl\site 46_ri.apr (RISoilSampleMap)

TABLE 2-1

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SURFACE SOIL SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Base-wide Background		Maryland Coastal Plain Range of Detection	Maximum Concentration for Site-Specific Background(1)
				Frequency of Detection	Range of Detection		
METAL IN SOILS (MG/KG)							
ALUMINUM	20/20	3390 - 12500	SS46-10	13/13	2,720 - 18,800	10,000 - 20,000	4610
ANTIMONY	5/20	0.62 - 3.5	SS47-9	0/13	--	< 1 - 1	--
ARSENIC	16/20	1.7 - 5	SS47-10	13/13	0.87 - 2.6	1.1 - 7.1	3.6
BARIUM	20/20	12.5 - 102	SS47-11	13/13	15.2 - 134	150 -300	76.1
BERYLLIUM	16/20	0.26 - 0.66	SS47-11	7/13	0.23 - 1.2	<1 - 7	0.53
CADMIUM	6/20	0.17 - 3.9	SS47-3	2/13	0.12 - 0.14	--	--
CALCIUM	20/20	43.7 - 13200	SS46-6	7/13	111 - 513	800 - 2,300	4130
CHROMIUM	20/20	5 - 18.1	SS46-10	11/13	3.7 - 17.0	15 - 20	6.7
COBALT	20/20	.96 - 8.2	SS47-9	11/13	0.64 - 23.7	<0.3 - 70	3.9
COPPER	19/20	2.8 - 90.8	SS47-3	3/13	1.9 - 3.7	7 - 10	10.2
IRON	20/20	5310 - 25300	SS46-10	13/13	1,980 - 14,700	5,000 - 10,000	6800
LEAD	20/20	8.8 - 62.6	SS47-3	13/13	8.6 - 20.8	10 - 15	24
MAGNESIUM	20/20	231 - 3750	SS47-3	13/13	248 - 1,270	500 - 1,000	564
MANGANESE	20/20	14.8 - 834	SS47-3	13/13	6.6 - 75	70 - 100	361
MERCURY	9/20	0.06 - 0.27	SS46-3	2/13	0.07 - 0.07	0.04 - 0.07	--
NICKEL	20/20	1.6 - 139	SS47-2	10/13	0.89 - 16.4	<5 - 5	5.6
POTASSIUM	19/20	234 - 961	SS46-10	10/13	219 - 880	4,500 - 7,900	881
SELENIUM	1/20	0.49	SS46-10	2/13	0.79 - 0.79	<0.1 - 0.4	1.1
SILVER	1/20	0.26	SS46-3	0/13	--	--	--
SODIUM	10/20	36.8 - 2190	SS47-3	0/13	--	<500 - 2,000	--
VANADIUM	20/20	10.9 - 30.4	SS46-10	13/13	7.3 - 33.4	20 - 30	14.6
ZINC	20/20	8.2 - 371	SS47-3	13/13	7.3 - 39.1	15 - 26	32.2
SEMIVOLATILE IN SOILS (MICROGRAMS/KG)							
2-METHYLNAPHTHALENE	6/20	27 - 240	SS47-10				--
ACENAPHTHENE	8/20	62 - 310	SS47-10				--
ACENAPHTHYLENE	1/20	150	SS47-6				--
ANTHRACENE	8/20	71 - 560	SS47-3				--
BENZO(A)ANTHRACENE	14/20	69 - 1600	SS47-5				--
BENZO(A)PYRENE	15/20	36 - 1900	SS47-3				--
BENZO(B)FLUORANTHENE	15/20	47 - 3700	SS47-3				--
BENZO(G,H,I)PERYLENE	12/20	30 - 1400	SS47-3				--
BENZO(K)FLUORANTHENE	9/20	46 - 980	SS47-5				–

TABLE 2-1

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SURFACE SOIL SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Base-wide Background		Maryland Coastal Plain Range of Detection	Maximum Concentration for Site-Specific Background[(1)]
				Frequency of Detection	Range of Detection		
CARBAZOLE	9 20	25 - 790	SS47-3				--
CHRYSENE	16/20	51 - 2700	SS47-3				--
DI-N-BUTYL PHTHALATE	3/20	29 - 58	SS46-10				--
DI-N-OCTYL PHTHALATE	3/20	45 - 92	SS47-9				--
DIBENZ(A,H)ANTHRACENE	6/20	51 - 430	SS47-5				--
DIBENZOFURAN	5/20	29 - 190	SS47-10				--
FLUORANTHENE	16/20	34 - 2900	SS47-5				--
FLUORENE	8/20	55 - 180	SS46-6				--
INDENO(1,2,3-CD)PYRENE	13/20	30 - 1100	SS47-3				--
NAPHTHALENE	5/20	42 - 360	SS47-10				--
PHENANTHRENE	15/20	52 - 3100	SS47-10				--
PYRENE	16/20	76 - 3600	SS47-3				--
PESTICIDE/PCB IN SOILS (UG/KG)							
4,4'-DDD	1/ 11	49	SS47-11	0/10	--		--
4,4'-DDE	5/ 11	4.2 - 250	SS47-11	0/10	--		--
4,4'-DDT	8/ 11	8.1 - 500	SS47-11	2/10	5.6 - 13.0		30
ALDRIN	1/ 11	0.33	SS46-9	0/10	--		--
AROCLOR-1254	2/ 16	420 - 7000	SS47-10				--
AROCLOR-1260	2/ 16	260 - 320	SS47-3				--
ENDOSULFAN I	0/11	--		0/10	--		9.4
ENDOSULFAN II	7/ 11	2.5 - 46	SS47-11	2/10	8.7 - 22.0		13
ENDRIN KETONE	2/ 11	1.1 - 2.8	SS46-8	0/10	--		--
METHOXYCHLOR	2/ 11	4 - 5	SS46-6	0/10	--		--
EXPLOSIVES IN SOILS (MICROGRAMSKG)							
RDX	0/11	--					377
VOLATILES IN SOILS (MICROGRAMS/KG)							
ACETONE	1/ 11	10	SS47-4				--
TOLUENE	3/ 11	1 - 11	SS47-5				--

Blank space indicates data not analyzed/not available.

-- Not detected

1 Data from SS47-00 and its duplicate SS47-00-D

TABLE 2-2

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SUBSURFACE SOIL SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Base-wide Background		Maximum Concentration for Site-Specific Background[1]
				Frequency of Detection	Range of Detection	
METAL IN SOILS (MG/KG)						
ALUMINUM	28/28	4890 - 16200	SB46-4(4)	9/9	182 - 14,000	7860
ANTIMONY	2/28	1.7 - 5	SB47-8(2)	0/9	--	--
ARSENIC	27/28	1.2 - 31.1	SB46-7(4)	6/9	0.93 - 3.3	5.3
BARIUM	28/28	12.9 - 107	SB46-7(2)	8/9	4.3 - 118	28.2
BERYLLIUM	25/28	0.25 - 0.69	SB46-3(2)	5/9	0.19 - 0.63	0.33
CALCIUM	18/28	28.7 - 2900	SB46-6(2)	2/9	421 - 539	281
CHROMIUM	28/28	5.8 - 36.5	SB46-4(4)	9/9	0.9 - 18.5	14.8
COBALT	28/28	0.56 - 6.4	SB47-6(4)	5/9	0.32 - 4.0	2
COPPER	26/28	2.7 - 91.4	SB47-8(2)	1/9	2.9	8.9
IRON	28/28	3260 - 67900	SB46-3(2)	9/9	830 - 11,800	15,600
LEAD	28/28	5.7 - 40.7	SB46-7(2)	7/9	254 - 12.0	9.3
MAGNESIUM	28/28	315 - 1600	SB46-4(4)	7/9	67.5 - 1,080	916
MANGANESE	28/28	13.2 - 237	SB47-7(2)	7/9	3.1 - 20.8	21.4
MERCURY	15/28	0.07 - 0.23	SB46-3(4)	0/9	--	--
NICKEL	28/28	1.4 - 219	SB46-7(2)	6/9	0.59 - 7.7	4.5
POTASSIUM	23/28	285 - 1890	SB46-4(4)	8/9	91.2 - 2,000	713
SELENIUM	3/28	1.4 - 2.8	SB47-8(2)	0/9	--	1.8
SODIUM	21/28	25.3 - 1070	SB47-8(2)	0/9	--	44.8
VANADIUM	28/28	9.7 - 61.1	SB46-5(4)	9/9	1.0 - 18.8	24.7
ZINC	28/28	7.8 - 109	SB47-8(2)	6/9	9.2 - 25.4	17.3
SEMIVOLATILE IN SOILS (MICROGRAMS/KG)						
2-METHYLNAPHTHALENE	4/28	70 - 600	SB46-7(4)			--
4-METHYLPHENOL	1/28	46	SB46-2(2)			--
ACENAPHTHENE	6/28	63 - 1300	SB46-7(4)			--
ACENAPHTHYLENE	1/28	340	SB46-2(2)			--
ANTHRACENE	6/28	48 - 1800	SB46-7(2)			--
BENZO(A)ANTHRACENE	8/28	58 - 6200	SB46-7(2)			--
BENZO(A)PYRENE	6/28	78 - 6200	SB46-2(2)			--
BENZO(B)FLUORANTHENE	7/28	36 - 5500	SB46-2(2)			--
BENZO(G,H,I)PERYLENE	4/28	170 - 1800	SB46-2(2)			--
BENZO(K)FLUORANTHENE	4/28	190 - 4900	SB46-2(2)			--
BIS(2-ETHYLHEXYL)PHTHALATE	1/28	3100	SB47-6(2)			--

TABLE 2-2

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SUBSURFACE SOIL SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 2 OF 2

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Base-wide Background		Maximum Concentration for Site-Specific Background[1]
				Frequency of Detection	Range of Detection	
CARBAZOLE	5/28	50 - 1100	SB46-2(2)			--
CHRYSENE	8/28	54 - 6100	SB46-7(2)			--
DI-N-BUTYL PHTHALATE	3/28	22 - 330	SB46-10(4)			--
DI-N-OCTYL PHTHALATE	5/28	36 - 98	SB47-6(2)			--
DIBENZ(A,H)ANTHRACENE	2/28	77 - 1600	SB46-7(2)			--
DIBENZOFURAN	5/28	97 - 630	SB46-7(2)			--
DIETHYL PHTHALATE	2/28	150 - 150	SB46-5(4)			--
FLUORANTHENE	8/28	230 - 12000	SB46-7(2)			--
FLUORENE	7/28	39 - 1000	SB46-7(4)			--
INDENO(1,2,3-CD)PYRENE	5/28	110 - 5000	SB46-2(2)			--
NAPHTHALENE	3/28	52 - 520	SB46-2(2)			--
PHENANTHRENE	8/28	180 - 9600	SB46-7(2)			--
PYRENE	9/28	38 - 11000	SB46-7(2)			--
PESTICIDE/PCB IN SOILS (MICROGRAMS/KG)						
4,4'-DDD	2/10	13 - 17	SB46-9(2)	--	--	--
4,4'-DDE	1/10	6.3	SB46-9(2)	--	--	--
4,4'-DDT	2/10	7.1 - 7.6	SB46-9(2)	--	--	--
AROCLOR-1254	2/13	140 - 210	SB46-8(2)	--	--	--
AROCLOR-1260	1/13	16	SB47-2(2)	--	--	--
VOLATILES IN SOILS (MICROGRAMS/KG)						
2-BUTANONE	1/11	21	SB47-2(2)			--
ACETONE	1/11	29	SB47-7(4)			--
CARBON DISULFIDE	1/11	8	SB47-8(2)			--
TOLUENE	2/11	2 - 40	SB47-4(2)			--

Blank space indicates not analyzed/not available.

-- Not detected

1 Data from SB47-00(2), SB47-00(2)-D, and SB4747-00(9)

All metals except selenium exceeded the site-specific background surface soil concentration (at location SS47-00) in at least one surface soil sample. All concentrations were within one order of magnitude of the base-wide background concentration, and the majority of the maximum concentrations for metals were found in samples located in the southwestern portion of the site. The most affected location was SS47-3, located near the marsh bordering the southwestern portion of the site.

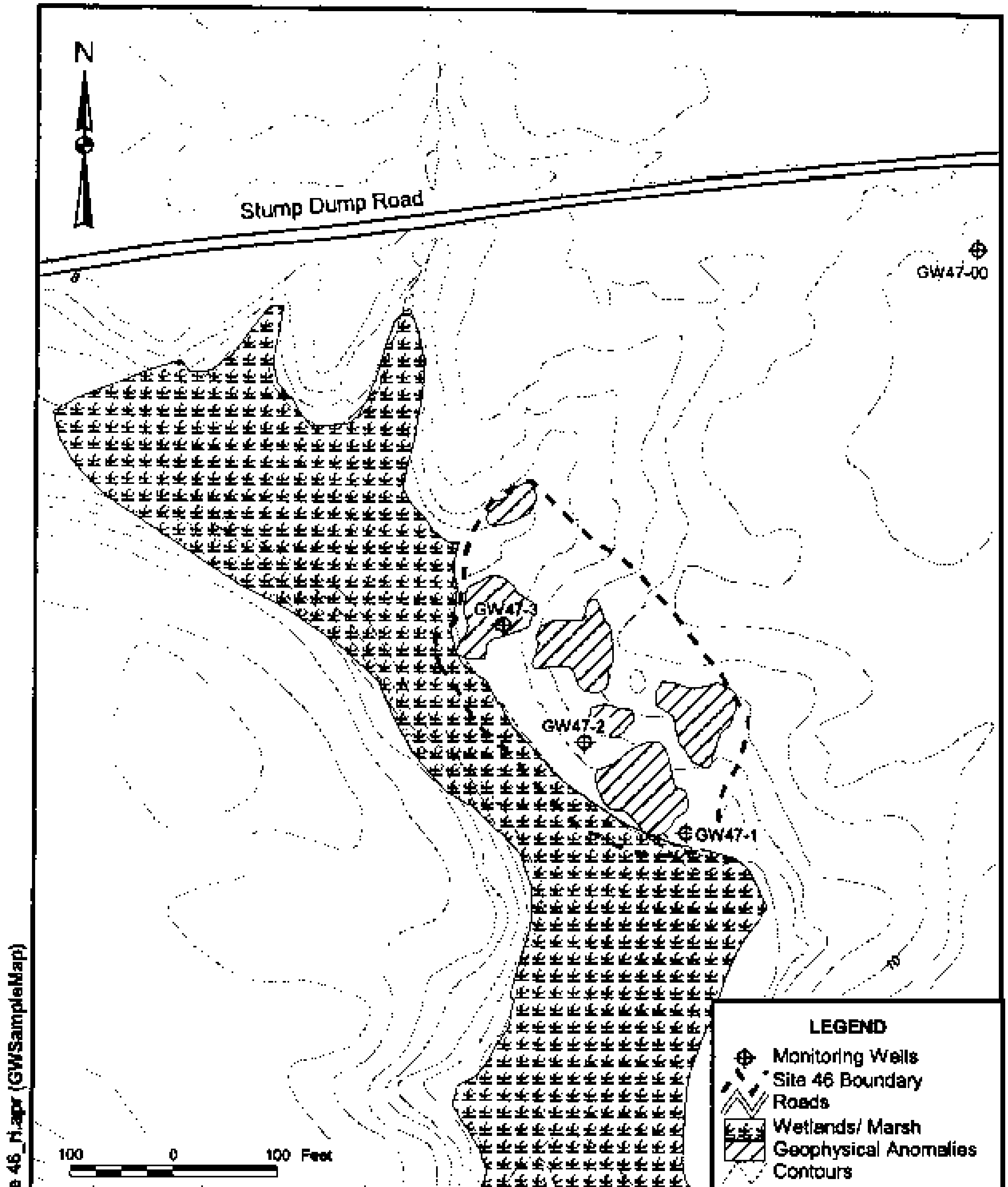
SVOCs detected in subsurface soil samples included 17 PAH compounds, four phthalates, 4-methylphenol, carbazole, and dibenzofuran. PAH compounds were detected sporadically at subsurface sample locations. A significant correlation does not exist between surface soil and subsurface soil results; the presence of these compounds in the subsurface soil probably results from filling activities and not vertical migration. However, the PCB compounds Aroclor-1254 and -1260 were detected in the subsurface soils at Site 46, and their distribution may indicate that vertical migration is occurring. The pesticide compounds 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD, were detected in low concentrations at two sample locations, but no evidence of vertical migration was indicated by the pesticide data.

All concentrations of inorganic chemicals in the subsurface soils were within an order of magnitude of the same metals found in the site-specific background samples and base-wide background samples, with the exception of nickel. The distribution of metals in subsurface soils at Site 46 was considered random, as would be expected within a fill area.

2.5.4.2 Groundwater

As discussed in Section 2.2.2, the 2000 FS sampling event was intended to provide information to determine whether samples collected during the previous RI sampling events represented accurate chemical concentrations groundwater. Groundwater sample locations are shown in Figure 2-6. Summaries of the occurrence and distribution of organic and inorganic chemicals in groundwater for the RI and FS sampling events are provided in Tables 2-3 and 2-4, respectively.

The concentrations of organic compounds previously detected in the groundwater during Rl sampling (1995/1997) were not present in groundwater monitoring wells GW47-2 and GW47-3 during the 2000 sampling event. However, organic compounds continued to be detected in groundwater monitoring well GW47-1 in the 2000 sampling event. During the 2000 sampling event, 11 SVOCs (2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, carbazole, dibenzofuran, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene) were detected in GW47-1 at concentrations ranging from 2 to 71 micrograms per liter (µg/L). Although detected during RI sampling, the SVOCs 2,4-dimethylphenol, 4-methylphenol, and bis (2-ethylhexyl) phthalate were not detected in any monitoring wells during the 2000 sampling event. No maximum contaminant levels (MCLs) have been established under the Federal Safe Drinking Water Act for the SVOCs detected during the 2000 sampling event.



DRAWN BY	DATE		CONTRACT NUMBER	OWNER NO.
LR	1/26/01	Tetra Tech NUS, Inc.	7316-1051	CTO 263
CHECKED BY KJC	DATE 1/26/01	GROUNDWATER SAMPLE LOCATIONS SITE 46 (FORMERLY SWMU 47) NSWCDL, DAHLGREN, VIRGINIA	APPROVED BY	DATE 08-03-01
COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. Figure 2-6	REV 0

TABLE 2-3

OCCURRENCE AND DISTRIBUTION OF ORGANIC CHEMICALS IN GROUNDWATER SAMPLES
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Analyte	1995 and 1997 Data[1]			2000 Data[2]		
	Frequency of Detection	Concentration Range	Location of Maximum	Frequency of Detection	Concentration Range	Location of Maximum
Semivolatiles (micograms/kg)						
2,4-DIMETHYLPHENOL	1 / 10	10	GW47-1(95)	ND[3]	NA [4]	NA
2-METHYLNAPHTHALENE	2 / 10	9 - 73	GW47-1(95)	1 / 3	2	GW47-1(00)
4-METHYLPHENOL	1 / 10	2	GW47-1(95)	ND	NA	NA
ACENAPHTHENE	5 / 10	2 - 73	GW47-1(97)	1 / 3	71	GW47-1(00)
ACENAPHTHYLENE	1 / 10	2	GW47-1(97)	1 / 3	1.4	GW47-1(00)
ANTHRACENE	2 / 10	5 - 7	GW47-1(95)	1 / 3	3.9	GW47-1(00)
BIS(2-ETHYLHEXYL)PHTHALATE	3 / 10	1 - 10	GW47-2(97)	ND	NA	NA
CARBAZOLE	2 / 10	25 - 35	GW47-1(95)	1 / 3	24	GW47-1(00)
DIBENZOFURAN	4 / 10	2 - 60	GW47-1(95)	1 / 3	48	GW47-1(00)
FLUORANTHENE	2 / 10	8 - 16	GW47-1(95)	1 / 3	12	GW47-1(00)
FLUORENE	4 / 10	2 - 59	GW47-1(97)	1 / 3	27	GW47-1(00)
NAPHTHALENE	4 / 10	2 - 130	GW47-1(95)	1 / 3	37	GW47-1(00)
PHENANTHRENE	2 / 10	62 - 66	GW47-1(95)	1 / 3	18	GW47-1(00)
PYRENE	2 / 10	6 - 9	GW47-1(95)	1 / 3	5.4	GW47-1(00)
Volatiles (micrograms/kg)						
ACETONE	1 / 5	16	GW47-2(95)	NA	NA	NA
XYLENE(TOTAL)	1 / 5	0.9	GW47-1(95)	NA	NA	NA

1 Includes samples (sampling year) GW47-00(95), GW47-00(95)-D, GW47-00(97), GW47-1(95), GW47-1(97), GW47-2(95), GW47-2(97), GW47-2(97)-D, GW47-3(95), GW47-3(97).

2 Includes samples GW47-1, GW47-2, GW47-3. GW47-00 (background sample) was sampled but not analyzed.

3 Not Detected.

4 Not Analyzed or Not Applicable.

TABLE 2-4

OCCURRENCE AND DISTRIBUTION OF INORGANIC CHEMICALS IN GROUNDWATER SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Analyte	1995 and 1997 Date(1)						2000 Data(2)					
	Unfiltered			Filtered			Unfiltered			Filtered		
	Frequency of Detection	Concentration Range	Location of Maximum	Frequency of Detection	Concentration Range	Location of Maximum	Frequency of Detection	Concentration Range	Location of Maximum	Frequency of Detection	Concentration Range	Location of Maximum
Metals (micrograms/kg)												
ALUMINUM	10 / 10	392 - 5360	GW47-00(95)	5 / 10	163 - 545	GW47-00(95)	1 / 3	600	GW47-2(00)	ND	NA	NA
ARSENIC	6 / 10	2.3 - 6.5	GW47-3(95)	1 / 10	3.2	GW47-2(97)	ND	NA	NA	ND	NA	NA
BARIUM	10 / 10	39.7 - 189	GW47-00(95)	10 / 10	30.4 - 170	GW47-2(95)	3 / 3	71 - 101	GW47-2(00)	3 / 3	66.9 - 102	GW47-2(00)
BERYLLIUM	2 / 10	1.6 - 1.7	GW47-00(95)	2 / 10	1.3 - 1.4	GW47-00(95)	ND	NA	NA	ND	NA	NA
CADMIUM	2 / 10	2.7 - 2.8	GW47-00(95)	2 / 10	1.8 - 2	GW47-00(95)	ND	NA	NA	ND	NA	NA
CALCIUM	10 / 10	7250 - 88300	GW47-2(95)	10 / 10	7360 - 88100	GW47-2(95)	3 / 3	38000 - 66200	GW47-2(00)	3 / 3	36000 - 70200	GW47-2(00)
CHROMIUM	9 / 10	1.4 - 11.6	GW47-3(95)	6 / 10	0.53 - 2.8	GW47-2(97)	ND	NA	NA	ND	NA	NA
COBALT	6 / 10	3 - 22.7	GW47-00(95)	6 / 10	1.7 - 21.6	GW47-00(95)	ND	NA	NA	ND	NA	NA
COPPER	6 / 10	4.4 - 15.5	GW47-00(95)	2 / 10	5 - 7.5	GW47-00(95)	ND	NA	NA	ND	NA	NA
IRON	10 / 10	468 - 25500	GW47-2(97)	9 / 10	57.7 - 22200	GW47-2(97)	3 / 3	12800 - 24700	GW47-3(00)	3 / 3	12400 - 21700	GW47-3(00)
LEAD	6 / 10	5.9 - 24.4	GW47-1(95)	ND	NA	NA	2 / 3	1.7 - 4.1	GW47-1(00)	1 / 3	2	GW47-1(00)
MAGNESIUM	10 / 10	3660 - 118000	GW47-2(95)	10 / 10	3690 - 115000	GW47-2(95)	3 / 3	58400 - 102000	GW47-2(00)	3 / 3	54100 - 108000	GW47-2(00)
MANGANESE	10 / 10	24.5 - 1620	GW47-2(97)	10 / 10	24.3 - 1550	GW47-2(97)	3 / 3	484 - 1270	GW47-2(00)	3 / 3	480 - 1330	GW47-2(00)
MERCURY	2 / 10	0.1 - 0.88	GW47-1(97)	ND	NA	NA	ND	NA	NA	ND	NA	NA
MERCURY (Low Detection)	5 / 5	0.00711 - 0.05697	GW47-00(97)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NICKEL	10 / 10	2.4 - 34.4	GW47-00(95)	10 / 10	1.4 - 31.4	GW47-00(95)	ND	NA	NA	ND	NA	NA
POTASSIUM	10 / 10	402 - 42100	GW47-2(95)	10 / 10	274 - 41300	GW47-2(95)	3 / 3	18700 - 31000	GW47-2(00)	3 / 3	17700 - 32500	GW47-2(00)
SELENIUM	5 / 10	2.6 - 3.9	GW47-1(95)	4 / 10	2.2 - 4.2	GW47-00(95)	ND	NA	NA	ND	NA	NA
SODIUM	10 / 10	10900 - 857000	GW47-2(95)	10 / 10	11200 -807000	GW47-2(95)	3 / 3	435000 - 714000	GW47-2(00)	3 / 3	409000 - 766000	GW47-2(00)
THALLIUM	1 / 10	6.5	GW47-3(95)	1 / 10	5.2	GW47-3(95)	ND	NA	NA	ND	NA	NA
VANADIUM	9 / 10	3.6 - 20.5	GW47-3(95)	3 / 10	1.6 - 2.1	GW47-2(95)	ND	ND	NA	ND	NA	NA
ZINC	9 / 10	14 - 86.4	GW47-00(95)	8 / 10	4.9 - 95.8	GW47-00(95)	3 / 3	126 - 165	GW47-3(00)	3 / 3	93.7 - 129	GW47-3(00)

1 Includes samples (sampling year) GW47-00(95), GW47-00(95)-D, GW47-00(95)-F, GW47-00(95)-F-D, GW47-00(97), GW47-00(97)-F, GW47-1(95), GW47-1(95)-F, GW47-1(97), GW47-1(97)-F, GW47-2(95), GW47-2(95)-F, GW47-2(97), GW47-2(97)-D, GW47-2(97)-F, GW47-2(97)-F-D, GW47-3(95), GW47-3(95)-F, GW47-3(97), GW47-3(97)-F.

2 Includes samples GW47-1, GW47-1-F, GW47-2, GW47-2-F, GW47-3, GW47-3-F. GW47-00 (background sample) was sampled but not analyzed.

3 Not Analyzed or Not Applicable.

4 Not Detected.

Several metals that were detected during previous RI sampling events were not detected in the 2000 sampling event. Metals not detected in the 2000 sampling event include arsenic, beryllium, cadmium, chromium, cobalt, copper, mercury, nickel, selenium, thallium, and vanadium. Although lead was detected during the RI at concentrations exceeding the Federal Action Level of 15 µg/L, concentrations were less than the Federal Action Level in the 2000 sampling event. Thallium was detected in the RI sampling event at a concentration exceeding the Federal Safe Drinking Water Act MCL of 2 µg/L, but was not detected in the 2000 sampling event.

In comparing RI data to FS data, it is evident that the metals concentrations were significantly lower when using the new sampling technique, suggesting that previous samples collected during the RI may not have been representative of chemical concentrations in the groundwater.

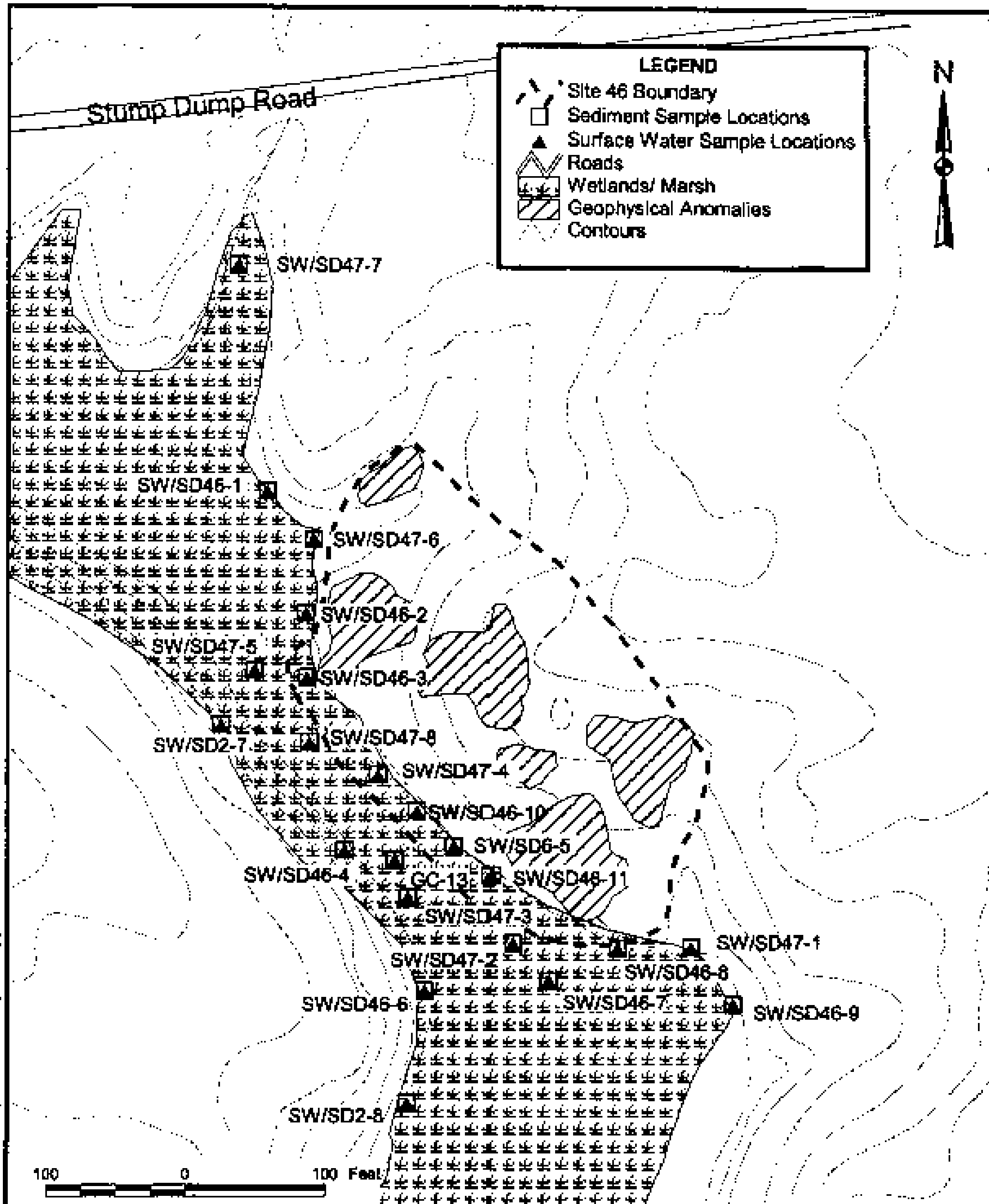
2.5.4.4 Sediments

Sediment sample locations are provided on Figure 2-7. A summary of the occurrence and distribution of organic and inorganic chemicals in sediment is provided in Table 2-5.

Sixteen PAH compounds, two phthalates, carbazole, and dibenzofuran were detected in sediments collected from Site 46. Based on information from sample concentrations and the sample locations, the extent of sediment affected by SVOCs is limited to the marsh directly adjacent to the shoreline of the site. These compounds have not migrated a significant distance from the site. No PCB compounds were detected in sediment samples collected at Site 46. During the RI, pesticide analysis was performed on three samples, and several pesticides were detected in low concentrations (see Table 2-5) in all three samples, as well as in samples collected in 1994. These pesticides were also found onsite in the surface soil samples. The concentrations are generally low and do not appear to be related to disposal activities at Site 46, but are more likely to be the result of historical base-wide aerial spraying.

As compared with background data from Gambo Creek, several metals were detected in the sediment at maximum concentrations in excess of background levels; however, they were not significantly elevated over background levels. The majority of maximum concentrations were detected in the marsh close to the southwest portion of the site.

The Gambo Creek Ecological Study, currently being performed, will determine the extent to which sediments are impacted by facility operations and will make recommendations for addressing sediments throughout the Gambo Creek watershed on NSWCDL.



DRAWN BY: LR	DATE: 10/31/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 7316-1051	OWNER NO: CTO 263
CHECKED BY: KL	DATE: 10/31/00	RI SURFACE WATER/ SEDIMENT SAMPLE LOCATIONS	APPROVED BY: [signature]	DATE: 08-03-01
COST/SCHEDULE-AREA		SITE 46 (FORMERLY SWMU 47)	APPROVED BY	DATE
SCALE: AS NOTED		NSWCDL, DAHLGREN, VIRGINIA	DRAWING NO.: Figure 2-7	REV: 0

k:\gproject\dahl\site 46_ri.apr (SW/SDSampleMap)

26 JAN 01 13:04

TABLE 2-5

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SEDIMENT SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCOL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Gambo Creek Background	
				Frequency of Detection	Range of Detection
METALS IN SEDIMENTS (MG/KG)					
ALUMINUM	21/ 21	2540 - 17800	SD12-4(94)	4/4	9,810 - 24,000
ANTIMONY	1/ 21	9.1	SD2-2(94)	0/4	--
ARSENIC	13/ 21	1.4 - 18.9	SD2-2(94)	4/4	1.8 - 9.7
BARIUM	21/ 21	21.4 - 188	SD12-4(94)	2/4	75.8 - 78.5
BERYLLIUM	4/ 21	0.4 - 1.8	SD47-3	4/4	1.1 - 2.5
CADIUM	2/ 21	0.92 - 1.7	SD47-3	0/4	--
CALCIUM	21/ 21	405 - 8600	SD2-8(94)	4/4	1,900 - 3,920
CHROMIUM	21/ 21	5 - 26.1	SD2-8(94)	4/4	14.2 - 28.8
COBALT	19/ 21	1.1 - 26.6	SD47-2	4/4	26.8 - 40.1
COPPER	20/ 21	4.7 - 49	SD46-7	4/4	12.9 - 22.5
IRON	21/ 21	5530 - 42300	SD46-7	4/4	19,500 - 35,200
LEAD	21/ 21	9.2 - 66.2	SD46-7	4/4	26.1 - 39.8
MAGNESIUM	21/ 21	442 - 9120	SD47-2	4/4	3,030 - 4,030
MANGANESE	21/ 21	17.8 - 999	SD2-8(94)	4/4	108 - 263
MERCURY	7/ 21	0.12 - 0.49	SD46-7	0/4	--
MERCURY (Low Detection)	9/ 9	0.0294 - 0.1089	SD46-4		
NICKEL	20/ 21	1.5 - 75.1	SD46-3	2/4	26.7 - 34.3
POTASSIUM	16/ 21	280 - 3470	SD47-2	4/4	1,380 - 2,410
SODIUM	19/ 21	289 - 40700	SD47-2	4/4	3,300 - 13,100
VANADIUM	21/ 21	11.3 - 53.9	SD46-3	4/4	22.6 - 39.4
ZINC	21/ 21	10.6 - 358	SD46-7	4/4	105 - 234
PESTICIDE/PCB IN SEDIMENTS (MICROGRAMS/KG)					
4,4'-DDD	3/ 6	3.3 - 18	SD46-10	2/4	0.0074 - 0.025
4,4'-DDE	3/ 6	4.5 - 6.7	SD46-10	2/4	0.02 - 0.029
4,4'DDT	4/ 6	2.9 - 8.9	SD46-5	2/4	0.0066 - 0.014

TABLE 2-5

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SEDIMENT SAMPLES
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Gambo Creek Background Frequency of Detection	Gambo Creek Background Range of Detection
ENDOSULFAN II	1/ 6	10	SD46-11	0/4	--
ENDRIN ALDEHYDE	2/ 6	4.1 - 16	SD12-4(94)	0/4	--
ENDRIN KETONE	3/ 6	3.7 - 7.6	SD46-11	0/4	--
HEPTACHLOR	1/ 6	3.7	SD12-4(94)	2/4	0.0076 - 0.008
METHOXYCHLOR	1/ 6	26	SD46-10	0/4	--
HERBICIDES IN SEDIMENTS (MICROGRAMS/KG)					
MONURON	2/ 5	7 - 1910	SD2-8(94)	2/4	0.005 - 0.009
SEMIVOLATILES IN SEDIMENTS (MICROGRAMS/KG)					
2-METHYLNAPHTHALENE	1/ 21	190	SD47-6		
ACENAPHTHENE	6/ 21	170 - 880	SD47-8		
ANTHRACENE	6/ 21	94 - 1100	SD47-8		
BENZO(A)ANTHRACENE	9/ 21	130 - 3000	SD47-8		
BENZO(A)PYRENE	9/ 21	82 - 2200	SD47-8		
BENZO(B)FLUORANTHENE	8/ 21	89 - 2800	SD47-8		
BENZO(G,H,I)PERYLENE	7/ 21	200 - 1400	SD47-8		
BENZO(K)FLUORANTHENE	9/ 21	80 - 2900	SD47-6		
BIS(2-ETHYLHEXYL)PHTHALATE	3/ 21	110 - 180	SD46-8-D		
CARBAZOLE	4/ 21	160 - 530	SD47-6		
CHRYSENE	9/ 21	160 - 2900	SD47-8		
DI-N-BUTYL PHTHALATE	1/ 21	590	SD46-4		
DIBENZ(A,H)ANTHRACENE	3/ 21	130 - 610	SD47-8		
DIBENZOFURAN	3/ 21	150 - 470	SD47-6		
FLUORANTHENE	9/ 21	450 - 5600	SD47-8		
FLUORENE	7/ 21	96 - 660	SD47-6		
INDENO(1,2,3-CD)PYRENE	7/ 21	250 - 1600	SD47-8		
NAPHTHALENE	2/ 21	98 - 610	SD47-6		

TABLE 2-5

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN SEDIMENT SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 3 OF 3

				Gambo Creek Background	
Chemical	**Frequency of Detection**	**Range of Detection**	**Location of Maximum**	**Frequency of Detection**	**Range of Detection**
PHENANTHRENE	8/ 21	340 - 5500	SD47-6		
PYRENE	9/ 21	510 - 5300	SD47-6		
VOLATILES IN SEDIMENTS (MICROGRAMS/KG)					
1,1,2,2-TETRACHLOROETHANE	1/ 12	28	SD47-2		
2-BUTANONE	5/ 12	22 - 80	SD47-1		
ACETONE	2/ 12	100 - 1400	SD47-2		
DIBROMOCHLOROMETHANE	1/ 12	12	SD47-2		
METHYLENE CHLORIDE	4/ 12	36 - 520	SD47-2		

Blank space indicates not analyzed/not available.

-- Not detected

2.5.4.5 Surface Water

During the RI, surface water was sampled for organic and inorganic chemicals; these locations are also shown in Figure 2-7 and the results are provided in Table 2-6. During the FS, selected locations were sampled for inorganic chemicals as shown in Figure 2-8. These results are provided on Table 2-7.

Based on the RI sampling results, 12 SVOCs (six PAHs, three phthalates, dibenzofuran, phenol, and 4-methylphenol) were detected in surface waters at Site 46. The extent of SVOC impacts to surface water appears to be confined to the area immediately adjacent to the shore along the site. No PCB compounds were detected in surface water samples collected at Site 46. Pesticides were not analyzed in surface water during the Site 46 RI, however, endrin was detected in one sample during the Gambo Creek Ecological Assessment.

Inorganic compounds detected in surface water samples were compared with background samples collected from the open water in Gambo Creek. All metals exceeded the site-specific background level in at least one surface water sample. During the 2000 FS sampling event, beryllium, cadmium, and silver were not detected. Arsenic, chromium, copper, iron, lead, mercury, nickel, and zinc concentrations exceeded either Federal or State Ambient Water Quality Criteria (AWQC). Most maximum concentrations were detected in samples obtained in the marsh just south of the shoreline, or in the creek just south of the marsh. During the 2000 sampling event, samples were collected using a methodology designed to minimize the presence of suspended solids and thus provide more representative metal concentrations in the surface water than those collected during previous RI sampling (1995/1997). However, the concentrations of the metals found in the surface water during the 2000 sampling event did not appear to be significantly different from those found in the RI sampling event, despite the change in methodology.

The Gambo Creek Ecological Study, currently being performed, will determine the extent to which surface water is impacted by facility operations and will make recommendations for addressing surface water throughout the Gambo Creek watershed on NSWCDL.

2.5.5 <u>Apparent Contaminant Migration</u>

Contaminants at Site 46 may be transported overland by erosion and in groundwater after being leached out by rain water infiltrating the soil. Unless transported by groundwater beneath the area of surface water influence, the mobile contaminants will be discharged to the marsh. Therefore, the influence of storm water and tides will disperse the more mobile contaminants (such as metals soluble in oxygenated

TABLE 2-6

OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN RI SURFACE WATER SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Gambo Creek Background		Federal AWQC[(1)]
				Frequency of Detection	Range of Detection	
METAL IN WATERS (MICROGRAMS/L)						
ALUMINUM	20/ 21	669 - 93200	SW46-8-D	3/4	548-668	
ARSENIC	7/ 21	3.9 - 38.7	SW46-8-D	2/4	3.1 - 7.6	0.0175
BARIUM	21/ 21	32.1 - 478	SW46-8-D	4/4	51.0 - 84.6	
BERYLLIUM	3/ 21	1.1 - 2.7	SW47-6	0/4	--	0.0641
CADMIUM	5/ 21	1.1 - 8.7	SW46-8-D	0/4	--	
CALCIUM	21/ 21	2090 - 90900	SW47-2	4/4	6,080 - 92,000	
CHROMIUM	16/ 21	1.5 - 142	SW46-8-D	0/4	--	3,433,000
COBALT	18/ 21	2.4 - 39.2	SW46-8-D	2/4	7.4 - 11.9	
COPPER	18/ 21	2.8 - 258	SW46-8-D	2/4	2.1 - 2.7	
IRON	21/ 21	578 - 281000	SW46-8-D	4/4	1,510 - 1,800	
LEAD	19/ 21	1 - 379	SW46-8-D	0/4	--	
MAGNESIUM	21/ 21	1770 - 210000	SW47-1-D	4/4	2,960 - 277,000	
MANGANESE	21/ 21	42.7 - 1700	SW46-2	4/4	177 - 657	100
MERCURY	3/ 21	0.25 - 0.78	SW46-8-D	0/4	--	0.146
MERCURY (Low Detection)	9/ 9	0.00449 - 0.1583	SW46-1	1/2	0.2	0.146
NICKEL	16/ 21	2.5 - 104	SW46-8-D	0/4	--	100
POTASSIUM	21/ 21	1010 - 62400	SW47-1-D	4/4	2,110 - 86,700	
SILVER	2/ 21	1.5 - 2.9	SW46-8-D	0/4	--	
SODIUM	21/ 21	5180 - 1680000	SW47-1-D	4/4	15,900 - 2,350,000	
VANADIUM	17/ 21	2.4 - 238	SW46-8-D	0/4	--	
ZINC	19/ 21	10.6 - 1070	SW46-8-D	2/4	27.7 - 56.8	

TABLE 2-6

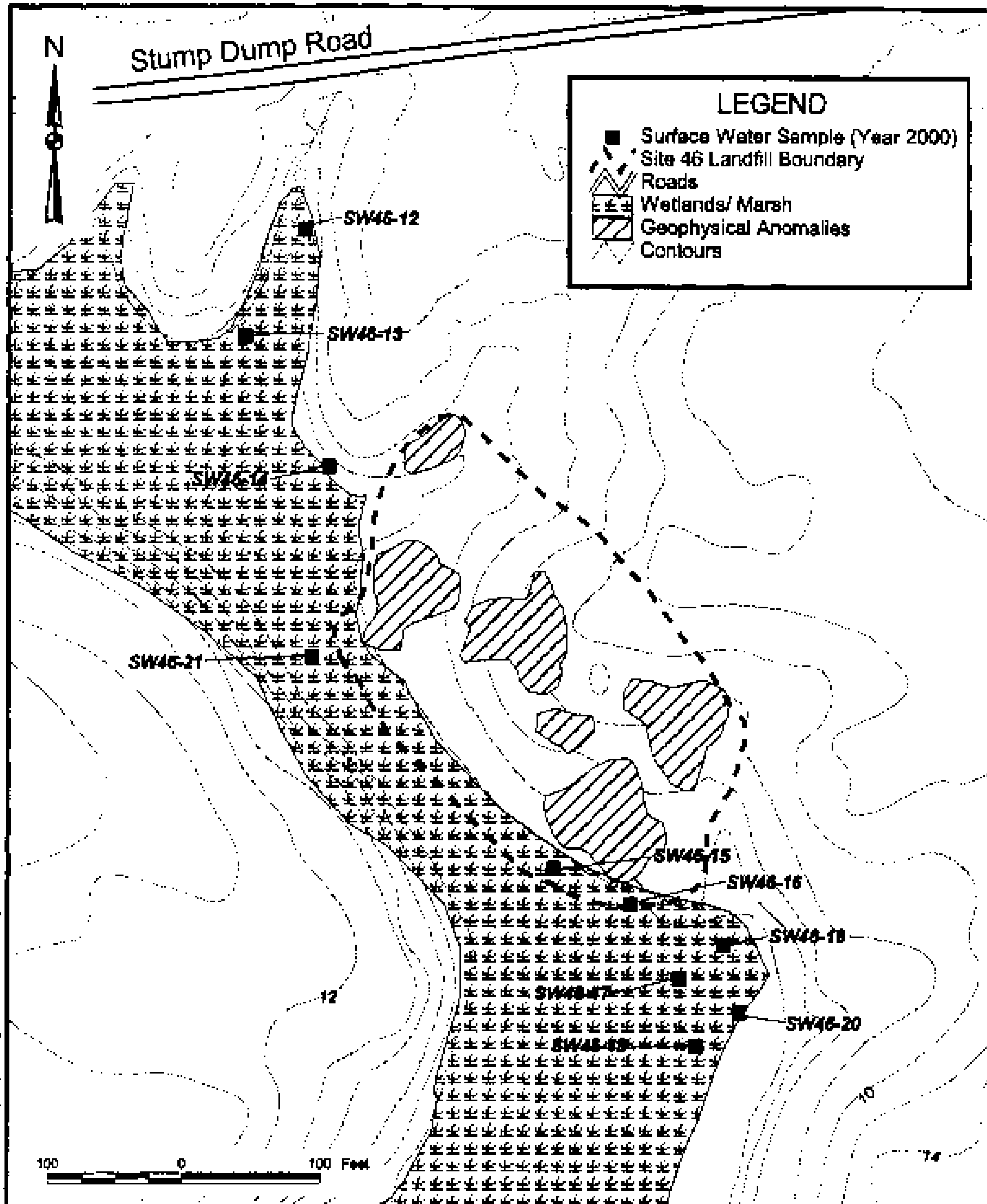
OCCURRENCE AND DISTRIBUTION OF ORGANIC AND INORGANIC CHEMICALS IN RI SURFACE WATER SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection	Location of Maximum	Gambo Creek Background		Federal AWQC[1]
				Frequency of Detection	Range of Detection	
PESTICIDE/PCBS WATERS (MICROGRAMS/L)						
4,4'-DDT	1/ 6	0.008	SW46-11	--	--	
SEMIVOLATILES IN WATERS (MICROGRAMS/L)						
4-METHYLPHENOL	1/ 21	2	SW47-2			
ACENAPHTHENE	2/ 21	0.5 - 11	SW46-8			
BENZO(K)FLUORANTHENE	1/ 21	0.6	SW47-5			
CHRYSENE	1/ 21	0.6	SW47-5			
DIBENZOFURAN	2/ 21		SW46-8			
FLUORANTHENE	1/ 21	0.9	SW47-5			54
FLUORENE	2/ 21		SW46-8			
PHENOL	1/ 21	3	SW47-2			
PYRENE	1/ 21	0.7	SW47-5			
VOLATILES IN WATERS (MICROGRAMS/L)						
1,1,2,2-TETRACHLOROETHANE	1/ 12	3	SW12-4(94)			
CARBON DISULFIDE	1/ 12	4	SW12-4(94)			
METHYLENE CHLORIDE	5/ 12	3 - 6	SW47-7			

Blank space indicates not analyzed/not available.

-- Not detected.

1 Ambient Water Quality Criteria.



DRAWN BY ECA, DATE 1/28/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER 7316-1051	OWNER NO CTO 263
CHECKED BY KJC, DATE 1/28/00	FS SURFACE WATER SAMPLE LOCATIONS SITE 46 NSWCDL, DAHLGREN, VIRGINIA	APPROVED BY [signature], DATE 08-03-01	
COST/SCHEDULE-AREA		APPROVED BY, DATE	
SCALE AS NOTED		DRAWING NO Figure 2-8	REV 0

k:\gproject\dahl\dahl_cto263.apr (Sample Locations)

TABLE 2-7

OCCURRENCE AND DISTRIBUTION OF INORGANIC CHEMICALS
RI AND FS SURFACE WATER SAMPLES
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

	1995 and 1997 Data[1]			2000 Data[2]		
Analyte	**Frequency of Detection**	**Concentration Range**	**Location of Maximum**	**Frequency of Detection**	**Concentration Range**	**Location of Maximum**
Metals (micrograms/L)						
ALUMINUM	17 / 18	669 - 93200	SW46-8	10 / 11	2150 - 85400	SW46-17
ANTIMONY	0 / 18	ND[3]	NA [4]	2 / 11	5 - 11.5	SW46-15
ARSENIC	7 / 18	3.9 - 38.7	SW46-8	11 / 11	2.5 - 64	SW46-15
BARIUM	18 / 18	32.1 - 478	SW46-8	11 / 11	72.2 - 1260	SW46-13
BERYLLIUM	3 / 18	1.1 - 2.7	SW47-6	0 / 11	ND	NA
CADMIUM	5 / 18	1.1 - 8.7	SW46-8	0 / 11	ND	NA
CALCIUM	18 / 18	12700 - 90900	SW47-2	11 / 11	8120 - 158000	SW46-15
CHROMIUM	16 / 18	1.5 - 142	SW46-8	6 / 11	44 - 127	SW46-16
COBALT	16 / 18	2.4 - 39.2	SW46-8	6 / 11	49.8 - 171	SW46-14
COPPER	16 / 18	5.8 - 258	SW46-8	6 / 11	37.7 - 252	SW46-15
IRON	18 / 18	1080 - 281000	SW46-8	11 / 11	3520 - 1190000	SW46-13
LEAD	16 / 18	3.4 - 379	SW46-8	11 / 11	3.2 - 755	SW46-15
MAGNESIUM	18 / 18	16900 - 210000	SW47-1	11 / 11	7090 - 192000	SW46-17
MANGANESE	18 / 18	42.7 - 1700	SW46-2	11 / 11	571 - 3390	SW46-17
MERCURY	3 / 18	0.25 - 0.78	SW46-8	9 / 11	0.12 - 1	SW46-14
MERCURY (Low Detection)	9 / 9	0.00449 - 0.1583	SW46-1	11 / 11	0.005 - 0.355	SW46-17
NICKEL	16 / 18	2.5 - 104	SW46-8	5 / 11	93 - 142	SW46-14
POTASSIUM	18 / 18	6000 - 62400	SW47-1	9 / 11	16600 - 53600	SW46-19
SELENIUM	0 / 18	ND	NA	3 / 11	3.2 - 4.5	SW46-14
SILVER	2 / 18	1.5 - 2.9	SW46-8	0 / 11	ND	NA
SODIUM	18 / 18	109000 - 1680000	SW47-7	11 / 11	33200 - 1370000	SW46-17
VANADIUM	17 / 18	2.4 - 238	SW46-8	8 / 11	20.4 - 228	SW46-17
ZINC	16 / 18	30.9 - 1070	SW46-8	7 / 11	205 - 1310	SW46-15

1 Includes samples SW46-1, SW46-2, SW46-3, SW46-4, SW46-6, SW46-7, SW46-8, SW46-8-D, SW46-9, SW47-1, SW47-1-D, SW47-2, SW47-3, SW47-4, SW47-5, SW47-6, SW47-7, SW47-8.

2 Includes samples SW46-12, SW46-12-D, SW46-13, SW46-14, SW46-15, SW46-16, SW46-17, SW46-18, SW46-19, SW46-20, SW46-21.

3 Not Detected.

4 Not Applicable.

brackish water) throughout the marsh, primarily downstream. Less mobile contaminants (pesticides, PAHs, and metals that are insoluble in the surface water) will be retained in the marsh sediment and eventually buried in this depositional environment. The RI and FS data indicate that contaminant migration from the Site 46 fill area has not been significant.

2.6 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land within a 0.5-mile radius of Site 46 is primarily undeveloped and wooded, and access is restricted due to the site's proximity to ordnance testing areas. Vehicular access to Stump Dump Road is restricted by a gate. The upland portion of Site 46 is currently designated as a seasonal hunting area. No current or future recreational use of the marsh is anticipated, due to its shallow depth and limited accessibility. The mission of the base is currently expanding and potential for future base closure and conversion to residential land use is considered minimal.

Shallow groundwater at NSWCDL is known to discharge to adjacent shallow water bodies such as the marsh adjacent to Site 46, rather than to migrate vertically through confining units. This is based on U.S. Geological Survey (USGS) studies that showed the ratio of median horizontal hydraulic conductivity of the water table aquifer to median vertical hydraulic conductivity of the upper confining unit to be 2,600:1. According to the USGS study, the water table aquifer at NSWCDL is of generally poor quality because of high, naturally occurring concentrations of some metals, especially iron and manganese. Poor water quality, coupled with the thin saturated thickness and locally high percentages of fine grained sediments, diminishes the potential use of the water table aquifer as an industrial or potable water source.

2.7 SUMMARY OF SITE RISKS

The human health and ecological risks associated with exposure to contaminated media at Site 46 were evaluated in the RI and FS Reports. No unacceptable human health risks are expected under the current and future scenarios evaluated. Plants and animals at the site are at risk due to concentrations of PAHs, pesticides (DDT compounds), PCBs, cadmium, mercury, and zinc in surface water and surface soil, and PAHs, cadmium, copper, lead, nickel, and zinc in sediment.

2.7.1 <u>Human Health Risks</u>

The baseline risk assessment estimates risks at the site if no remedial action is taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. As explained by the USEPA ROD guidance document, the primary focus of this summary should be on those exposure pathways and chemicals found to pose actual or potential threats to human health, and should be relevant to the action proposed in this ROD. Because the results of the human health risk assessment presented in the RI and FS indicate that remedial efforts are not required (based on human health risk drivers), this section is limited to a brief description of the human health risk assessment results.

Identification of Chemicals of Potential Concern

Table 2-8 presents the chemicals of potential concern (COPCs) and exposure point concentration (EPC) for each of the COPCs detected in soil, fish tissue via surface water, and groundwater. The table includes the range of concentrations detected for each COPC, as well as the frequency of detection (i.e., the number of times the chemical was detected in the samples collected at the site), the EPC, and how the EPC was derived. Fish tissue concentrations were calculated using surface water concentrations multiplied by chemical-specific bioconcentration factors. No COPCs were identified in surface water or sediment because of the anticipated lack of exposure to these media (i.e., inaccessibility, the presence of snakes and snapping turtles, and heavy vegetation).

Exposure Assessment

In the RI, recreational users (adults and children) were evaluated as current potential receptors in the baseline human health risk assessment for exposure to surface soil (0 to 2 feet bgs). Ingestion of fish was evaluated for adult recreational users only. Potential future receptors included construction workers, commercial workers, and hypothetical future onsite residents. Construction workers and commercial workers were evaluated for exposure to surface and subsurface soil (to an estimated maximum depth of 12 feet bgs). Potential future onsite residents were evaluated for exposure to surface and subsurface soils. Base workers were not evaluated because no regular duties or maintenance activities are performed at Site 46. Groundwater risk presented in the RI was revised in the FS, based on additional groundwater samples collected in July 2000. Hypothetical future residents (adults and children) and construction workers were evaluated as potential receptors in the revised risk assessment. Construction workers were evaluated for exposure to groundwater by dermal contact; hypothetical future residents were also evaluated for exposure to groundwater by ingestion, dermal contact, and inhalation.

Inhalation of volatile emissions and dust was evaluated qualitatively in the RI via a comparison of site data to USEPA generic Soil Screening Levels (SSLs) for transfers from soil to air. Inhalation exposure was considered to be relatively insignificant because all detected soil concentrations were less than the SSLs. In addition, the majority of the site is vegetated, thereby reducing the generation of dust via wind erosion.

TABLE 2-8

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Exposure Point	Chemical of Potential Concern	Units	Minimum Concentration	Maximum Concentration	Frequency of Detection	Exposure Point Concentration	EPC Units	Statistical Measure
Ingestion and dermal contact with chemicals in surface soil - Industrial and Recreational Exposure Scenarios	Arsenic	mg/kg	1.7	5	16/20	3.6	mg/kg	95% UCL-T(1)
	Benzo(a)pyrene	mg/kg	0.05	1.9	15/20	1	mg/kg	95% UCL-T
	Aroclor-1254	mg/kg	0.42	7	2/16	0.61	mg/kg	95% UCL-T
Ingestion and dermal contact with chemicals in surface soil - Residential Exposure Scenario	Antimony	mg/kg	0.62	3.5	5/20	2.3	mg/kg	95% UCL-T
	Arsenic	mg/kg	1.7	5	16/20	3.6	mg/kg	95% UCL-T
	Cadmium	mg/kg	0.17	3.9	6/20	1.3	mg/kg	95% UCL-T
	Iron	mg/kg	5,310	25,300	20/20	14,935	mg/kg	95% UCL-T
	Manganese	mg/kg	14.8	834	20/20	381	mg/kg	95% UCL-T
	Benzo(a)anthracene	mg/kg	0.69	1.6	14/20	1.08	mg/kg	95% UCL-T
	Benzo(a)pyrene	mg/kg	0.05	1.9	15/20	1	mg/kg	95% UCL-T
	Benzo(b)fluoranthene	mg/kg	0.047	3.7	15/20	1.9	mg/kg	95% UCL-T
	Dibenz(a,h)anthracene	mg/kg	0.051	0.43	6/20	0.43	mg/kg	Maximum(2)
	Indeno(1,2,3-cd)pyrene	mg/kg	0.03	1.1	13/20	0.67	mg/kg	95% UCL-T
	Aroclor-1254	mg/kg	0.42	7	2/16	0.61	mg/kg	95% UCL-T
	Aroclor-1260	mg/kg	0.26	0.32	2/16	0.08	mg/kg	95% UCL-T
Ingestion and dermal contact with chemicals in surface/subsurface soil - Industrial and Recreational Exposure Scenarios	Arsenic	mg/kg	1.2	31.1	43/48	6	mg/kg	95% UCL-T
	Iron	mg/kg	3,260	67,900	48/48	23,300	mg/kg	95% UCL-T
	Benzo(a)pyrene	mg/kg	0.05	6.2	21/48	0.64	mg/kg	95% UCL-T
	Dibenz(a,h)anthracene	mg/kg	0.051	1.6	8/48	0.33	mg/kg	95% UCL-T
	Aroclor-1254	mg/kg	0.14	7	4/29	0.17	mg/kg	95% UCL-T

TABLE 2-8

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Exposure Point	Chemical of Potential Concern	Units	Minimum Concentration	Maximum Concentration	Frequency of Detection	Exposure Point Concentration	EPC Units	Statistical Measure
Ingestion and dermal contact with chemicals in surface/subsurface soil - Residential Exposure Scenario	Antimony	mg/kg	0.62	5	7/46	2.9	mg/kg	95% UCL-T
	Arsenic	mg/kg	1.2	31.1	43/48	6	mg/kg	95% UCL-T
	Chromium	mg/kg	5	36.5	48/48	30	mg/kg	95% UCL-T
	Iron	mg/kg	3,260	67,900	48/48	23,300	mg/kg	95% UCL-T
	Manganese	mg/kg	13.2	834	48/48	171	mg/kg	95% UCL-T
	Nickel	mg/kg	1.4	219	48/48	40.3	mg/kg	95% UCL-T
	Vanadium	mg/kg	9.7	61.1	48/48	26.5	mg/kg	95% UCL-T
	Benzo(a)anthracene	mg/kg	0.058	6.2	22/48	1.55	mg/kg	95% UCL-T
	Benzo(a)pyrene	mg/kg	0.05	6.2	21/48	0.64	mg/kg	95% UCL-T
	Benzo(b)fluoranthene	mg/kg	0.036	5.5	22/48	1.84	mg/kg	95% UCL-T
	Dibenz(a,h)anthracene	mg/kg	0.051	1.6	8/48	0.33	mg/kg	95% UCL-T
	Indeno(1,2,3-cd)pyrene	mg/kg	0.03	5	18/48	1.05	mg/kg	95% UCL-T
	Aroclor- 1254	mg/kg	0.14	7	4/29	0.17	mg/kg	95% UCL-T
	Aroclor- 1260	mg/kg	0.016	0.32	3/29	0.08	mg/kg	95% UCL-T
Ingestion and dermal contact with chemicals in fish tissue(3)	Aluminum	mg/kg	6.69	932	17/19	322	mg/kg	95% UCL-T
	Arsenic	mg/kg	0.172	1.7	7/19	0.480	mg/kg	95% UCL-T
	Cadmium	mg/kg	0.070	0.557	5/19	0.102	mg/kg	95% UCL-T
	Chromium	mg/kg	0.024	2.27	15/19	0.309	mg/kg	95% UCL-T
	Cobalt	mg/kg	3.12	51.0	15/19	26	mg/kg	95% UCL-T
	Copper	mg/kg	0.209	9.29	15/19	3.36	mg/kg	95% UCL-T
	Iron	mg/kg	10.8	281	19/19	2,080	mg/kg	95% UCL-T
	Manganese	mg/kg	0.427	17	19/19	10.5	mg/kg	95% UCL-T
	Mercury (methyl)	mg/kg	1.15	15.6	19/19	2.48	mg/kg	95% UCL-T
	Nickel	mg/kg	0.118	4.89	16/19	2.91	mg/kg	95% UCL-T
	Thallium	mg/kg	0.418	0.557	2/19	0.348	mg/kg	95% UCL-T
	Vanadium	mg/kg	0.024	2.38	17/19	0.615	mg/kg	95% UCL-T
	Zinc	mg/kg	1.45	51.3	15/19	31.3	mg/kg	95% UCL-T
	Dibenzofuran	mg/kg	1.59	1.59	2/19	1.59	mg/kg	Maximum(2)
	4,4'-DDT	mg/kg	0.429	0.429	1/5	0.429	mg/kg	Maximum(4)
	Endrin	mg/kg	0.032	0.032	1/5	0.032	mg/kg	Maximum(4)

TABLE 2-8

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
Page 3 of 3

Exposure Point	Chemical of Potential Concern	Units	Minimum Concentration	Maximum Concentration	Frequency of Detection	Exposure Point Concentration	EPC Units	Statistical Measure
Ingestion, dermal contact, and inhalation of chemicals in Groundwater - Residential Exposure Scenario	Iron	µg/L (5)	12800	24700	3/3	24700	µg/L	Maximum (4)
	Manganese	µg/L	484	1270	3/3	1270	µg/L	Maximum (4)
	Acenaphthene	µg/L	71	71	1/3	71	µg/L	Maximum (4)
	Carbazole	µg/L	24	24	1/3	24	µg/L	Maximum (4)
	Dibenzofuran	µg/L	48	48	1/3	48	µg/L	Maximum (4)
	Fluorene	µg/L	27	27	1/3	27	µg/L	Maximum (4)
	Naphthalene	µg/L	37	37	1/3	37	µg/L	Maximum (4)
	Phenanthrene	µg/L	18	18	1/3	18	µg/L	Maximum (4)

1 95% UCL-T = 95% UCL of Log-transformed Data

2 Maximum concentration used because 95% UCL exceeds the maximum.

3 Theoretical fish tissue concentrations calculated using surface water concentrations multiplied by chemical-specific bioconcentration factors.

4 Data set consists of less than 10 samples. Maximum concentrations were used for the RME and CTE..

5 µg/L = micrograms/liter

Toxicity Assessment

Table 2-9 summarizes carcinogenic risk information which is relevant to the COPCs in all media evaluated. Cancer slope factors (CSFs) have been developed by USEPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CSFs are multiplied by the estimated intake of potential carcinogen, in mg/kg-day, to provide an upper bound estimate of the excess lifetime cancer risk associated with exposure at the intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CSFs. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied.

Table 2-10 summarizes non-carcinogenic risk information which is relevant to the COPCs in all media evaluated. Reference doses (RfDs) have been developed by the USEPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared with the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur.

Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

where:

Risk = a unitless probability (e.g., 1×10^{-6}) of an individual developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$

TABLE 2-9

CANCER TOXICITY DATA -- ORAL/DERMAL
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical of Potential Concern	Oral CSF	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor(1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date(2)
Arsenic	1.5	0.95	1.58	$(mg/kg\text{-}day)^{-1}$	A	IRIS	10/5/00
Benzo(a)anthracene	7.3E-01	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Benzo(a)pyrene	7.3E+00	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Benzo(b)fluoranthene	7.3E-01	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Diobenz(a,h)anthracene	7.3E+00	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Indeno(1,2,3-cd)pyrene	7.3E-01	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Carbazole	2.0E-02	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Aroclor-1254	2.0E+00	1	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
Aroclor-1260	2.0E+00	1	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00
4,4'-DDT	3.4E-01	NA	NA	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	10/5/00

1 CSFdermal = CSForal/(Oral to Dermal Adjustment Factor)

2 Date of IRIS

Notes:

CSF = Cancer Slope Factor

IRIS = Integrated Risk Information System, on-line database search (USEPA, October 2000)

NA = Not Applicable

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

TABLE 2-10

NON-CANCER TOXICITY DATA - ORAL/DERMAL
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD	Oral RfD Units	Oral to Dermal Adjustment Factor	Adjusted Dermal RfD[1]	Dermal RfD Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ[2]
Aluminum	chronic	1.0E+00	mg/kg-day	0.05	5.00E-02	mg/kg-day	Immune System	300	NCEA	10/5/00
Antimony	chronic	4.0E-04	mg/kg-day	0.05	2.00E-05	mg/kg-day	Lifespan	1,000	IRIS	10/5/00
Arsenic	chronic	3.0E-04	mg/kg-day	0.95	2.85E-04	mg/kg-day	Vascular,Skin	3	IRIS	10/5/00
Cadmium (water)	chronic	5.0E-04	mg/kg-day	0.05	2.50E-05	mg/kg-day	Kidney	10	IRIS	10/5/00
Cadmium (food)	chronic	1.0E-03	mg/kg-day	0.05	5.00E-05	mg/kg-day	Kidney	10	IRIS	10/5/00
Chromium (total)	chronic	3.0E-03	mg/kg-day	0.025	7.50E-05	mg/kg-day	NOAEL	1,000	IRIS	10/5/00
Cobalt	chronic	6.0E-02	mg/kg-day	NA[3]	NA	mg/kg-day	Cardiovascular, Immuniological, Neurological		NCEA	10/5/00
Copper	chronic	4.0E-02	mg/kg-day	NA	NA	mg/kg-day			HEAST	07/97
Iron	chronic	3.0E-01	mg/kg-day	1	3.00E-01	mg/kg-day	Liver, Blood, GI Tract		NCEA	10/5/00
Manganese	chronic	2.0E-02	mg/kg-day	0.03	6.00E-04	mg/kg-day	CNS	1	IRIS	10/5/00
Mercury (methyl)	chronic	1.0E-04	mg/kg-day	NA	NA	mg/kg-day	CNS	10	IRIS	10/5/00
Nickel	chronic	2.0E-02	mg/kg-day	0.04	8.00E-04	mg/kg-day	Decreased body/ organ weights	300	IRIS	10/5/00
Thallium	chronic	7.0E-05	mg/kg-day	NA	NA	mg/kg-day	Liver		Other[3]	10/5/00
Vanadium	chronic	7.0E-03	mg/kg-day	0.026	1.82E-04	mg/kg-day	NOEL	100	HEAST	07/97
Zinc	chronic	3.0E-01	mg/kg-day	1	3.00E-01	mg/kg-day	Blood	3	IRIS	10/5/00
Acenaphthene	chronic	6.0E-02	mg/kg-day	0.7	4.20E-02	mg/kg-day	Liver	3,000	IRIS	10/5/00
Dibenzofuran	chronic	4.0E-03	mg/kg-day	1	400.E-03	mg/kg-day			NCEA	10/5/00
Fluorene	chronic	4.0E-02	mg/kg-day	0.7	2.08E-02	mg/kg-day	Blood	3,000	IRIS	10/5/00
Naphthalene	chronic	2.0E-02	mg/kg-day	0.8	1.60E-02	mg/kg-day	Body Weight	3,000	IRIS	10/5/00
Phenanthrene	chronic	2.0E-02	mg/kg-day	0.8	1.60E-02	mg/kg-day	Body Weight	3,000	IRIS	10/5/00
Aroclor-1254	chronic	2.0E-05	mg/kg-day	1	2.00E-05	mg/kg-day	Immunological, Nails	300	IRIS	10/5/00
4,4'-DDT	chronic	5.0E-04	mg/kg-day	NA	NA	mg/kg-day	Liver	100	IRIS	10/5/00
Endrin	chronic	3.0E-04	mg/kg-day	NA	NA	mg/kg-day	Liver	100	IRIS	10/5/00

1 RfD dermal = RfDoral x (Oral to Dermal Adjustment Factor)
2 Dates of IRIS, HEAST, or NCEA
3 NA - Not Applicable. Constituent is evaluated for fish ingestion pathway only.
4 Developed by USEPA Region III based weighted average of RfDs of thallium compounds.

Notes: RfD = Reference dose
CNS = Central Nervous System
IRIS = Integrated Risk Information System, on-line database search (USEPA, October 2000)
NCEA = USEPA National Center for Environmental Assessment (USEPA RBC Table, October 2000)
NOAEL = No Observed Adverse Effect Level
NOAEL = No Observed Effect Level

These risks are probabilities that usually are expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of 1 x 10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. USEPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6} .

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., life time) with a RfD derived for a similar exposure period. An RfD represents a level that an individual may be exposed to without deleterious effects. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQ's from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposure may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD

where:

CDI = Chronic daily intake
RfD = Reference dose.

CDI and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or short-term).

Quantitative estimates of carcinogenic and noncarcinogenic risks (Incremental Cancer Risks [ICRs] and Hazard Indexes [Hls] , respectively) are summarized in Tables 2-11 through 2-19 for recreational users (adults and children), future construction workers, future residents, and future commercial workers.

TABLE 2-11

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - ADULT RECREATIONAL USER
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Current / Future
Receptor Population: Recreational User
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)pyrene	4.1E-07			4.1E-07	Benzo(a)pyrene					
			Aroclor-1254	6.8E-08		4.4E-08	1.1E-07	Aroclor-1254	Immunological, Nails	4.8E-03		3.1E-03	7.9E-03
			Arsenic	3.0E-07		4.4E-08	3.5E-07	Arsenic	Liver, Blood, GI Tract	1.9E-03		2.7E-04	2.2E-04
Surface Water	Fish Tissue	Fish Tissue	Dibenzofuran					Dibenzofuran		1.4E-01			1.4E-01
			4,4'-DDT	2.2E-05			2.2E-05	4,4'-DDT	Liver	3.1E-01			3.1E-01
			Endrin					Endrin	Liver	3.8E-02			3.8E-02
			Aluminum					Aluminum	Immune System	1.2E-01			1.2E-01
			Arsenic	1.1E-04			1.1E-04	Arsenic	Vascular,Skin	5.7E-01			5.7E-01
			Cadmium					Cadmium	Kidney	3.7E-02			3.7E-02
			Chromium VI					Chromium VI	NOAEL	3.7E-02			3.7E-02
			Cobalt					Cobalt	Cardiovascular, Immunoligical, Neurological	1.5E-01			1.5E-01
			Copper					Copper		3.0E-02			3.0E-02
			Iron					Iron	Liver, Blood, GI Tract	2.5E+00			2.5E+00
			Maganese					Maganese	CNS	2.7E-02			2.7E-02
			Mercury(methyl)					Mercury(methyl)	CNS	8.9E+00			8.9E+00
			Nickel					Nickel	Decreased body/ organ weights	5.2E-02			5.2E-02
			Thallium					Thallium	Liver	1.8E+00			1.8E+00
			Vandium					Vandium	NOEL	3.1E-02			3.1E-02
			Zinc					Zinc	Blood	3.7E-02			3.7E-02

Total Risk Across Surface Soil	8.7E-07
Total Risk Across Fish Ingestion	1.3E-04
Total Risk Across All Media and All Exposure Routes	1.3E-04

Total Hazard Index Across All Media and All Exposure Routes	15
Total Liver HI =	04.6E+00
Total CNS HI =	8.9E+00
Total Blood HI =	2.5E+00
Total Skin HI =	5.7E-01
Total Vascular HI =	5.7E-01
Total Cardiovascular HI =	1.5E-01
Total Immune System HI =	2.8E-01
Total GI Tract HI =	2.5E+00
Total Kidney HI =	3.7E-02
Total Neurological HI =	1.5E-01

TABLE 2-12

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPs - CHILD RECREATIONAL USER
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Current / Future
Receptor Population: Recreational User
Receptor Age: Child (3 - 12 years of age)

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Non-Carcinogenic Hazard Quotient: Ingestion	Non-Carcinogenic Hazard Quotient: Inhalation	Non-Carcinogenic Hazard Quotient: Dermal	Non-Carcinogenic Hazard Quotient: Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)pyrene	8.2E-07			8.2E-07	Benzo(a)pyrene					
			Aroclor-1254	1.4E-07		5.4E-08	1.9E-07	Arclor-1254	Immunological, Nails	2.7E-02		1.1E-02	3.7E-02
			Arsenic	6.1E-07		5.4E-08	6.6E-07	Arsenic	Liver, Blood, GI Tract	1.1E-02		9.3E-04	1.1E-02
						Total Risk Across Surface Soil	1.7E-06				Total Hazard Index Across All Media and All Exposure Routes		0.049

Total Risk Across All Media and All Exposure Routes: 1.7E-06

Total Liver HI =	1.1E-02
Total Blood HI =	1.1E-02
Total GI Tract HI =	1.1E-02
Total Immune System HI =	3.7E-02

TABLE 2-13

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - CONSTRUCTION WORKER
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: Exposure Routes Total	Chemical	Primary Target Organ	Non-Carcinogenic Hazard Quotient: Ingestion	Non-Carcinogenic Hazard Quotient: Inhalation	Non-Carcinogenic Hazard Quotient: Dermal	Non-Carcinogenic Hazard Quotient: Exposure Routes Total
Soil	Soil	Surface and Subsurface Soil	Benzo(a)pyrene	2.26E-07			2.3E-07	Benzo(a)pyrene					
			Dibenz(a,h)anthracene	1.2E-07			1.2E-07	Dibenz(a,h)anthracene					
			Aroclor-1254	1.6E-08		2.6E-09	1.9E-08	Arcolor-1254	Immunological, Nails	2.9E-02		4.6E-03	3.3E-02
			Arsenic	4.3E-07		1.6E-08	4.5E-07	Arsenic	Vascular, Skin	6.8E-02		2.5E-03	7.0E-02
			Iron					Iron	Liver, Blood, GI Tract	2.6E-01		3.0E-03	2.7E-01
Groundwater	Water /Air	Onsite	Acenaphthene					Acenaphthene	Liver			1.0E-01	1.0E-01
			Carbazole					Carbazole					
			Dibenzofuran					Dibenzofuran				9.1E-01	9.1E-01
			Fluorene					Fluorene	Blood			7.4E-02	7.4E-02
			Naphthalene					Naphthalene	Body Weight			8.2E-02	8.2E-02
			Phenanthrene					Phenanthrene	Body Weight			9.0E-02	9.0E-02
			Iron					Iron	Liver, Blood, GI Tract			4.2E-02	4.2E-02
			Maganese					Maganese	CNS			8.1E-01	8.1E-01

Total Risk Across Surface Soil	8.1E-07
Total Risk Across Groundwater	
Total Risk Across All Media and All Exposure Routes	8.1E-07

Total Hazard Index Across All Media and All Exposure Routes	2.5
Total Liver HI =	4.1E -01
Total CNS HI =	8.1E-01
Total Blood HI=	3.1E-01
Total Immune System HI =	3.3E-02
Total Body Weight HI =	1.7E-01
Total Vascular HI =	7.0E-02
Total Lifetime HI =	8.4E-01
Total GI Tract H1 =	3.1E-01
Total Skin HI =	7.0E-02

TABLE 2-14

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs -FUTURE ADULT RESIDENT
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

				Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
Medium	Exposure Medium	Exposure Point	Chemical	Ingestion	Inhalation	Dermal	Exposure Routes Total	Chemical	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)anthracene	3.69E-07			3.7E-07	Benzo(a)anthracene					
			Benzo(a)pyrene	3.4E-06			3.4E-06	Benzo(a)pyrene					
			Benzo(b)fluoranthene	6.5E-07			6.5E-07	Benzo(b)fluoranthene					
			Dibenz(a,h)anthracene	1.5E-06			1.5E-06	Dibenz(a,h)anthracene					
			Indeno(1,2,3-cd)pyrene	2.3E-07			2.3E-07	Indeno(1,2,3-cd)pyrene					
			Aroclor-1254	5.8E-07		4.7E-06	5.3E-06	Arcolor-1254	Immunological, Nails	4.2E-02		3.4E-01	3.8E-01
			Aroclor-1260	7.8E-08		6.3E-07	7.1E-07	Aroclor-1260					
			Antimony					Antimony	Lifespan	7.9E-03		9.2E-02	9.9E-02
			Arsenic	2.5E-06		4.6E-06	7.1E-06	Arsenic	Vascular, Skin	1.6E-02		3.0E-02	4.6E-02
			Cadmium					Cadmium	Kidney	1.8E-03		2.1E-02	2.3E-02
			Iron					Iron	Liver, Blood, GI Tract	6.8E-02		4.0E-02	1.1E-01
			Maganese					Maganese	CNS	2.6E-02		5.0E-01	5.3E-01
Groundwater	Water /Air	Onsite	Acenaphthene					Acenaphthene	Liver	3.2E-02		8.3E-02	1.2E-01
			Carbazole	4.5E-06			4.5E-06	Carbazole					
			Dibenzofuran					Dibenzofuran		3.3E-01		8.3E-01	1.2E+00
			Fluorene					Fluorene	Blood	1.8E-01		6.8E-02	8.6E-02
			Naphthalene					Naphthalene	Body Weight	5.1E-02	2.4E-01	5.1E-02	3.4E-01
			Phenanthrene					Phenanthrene	Body Weight	2.5E-02	2.2E-02	7.5E-02	1.2E-01
			Iron					Iron	Liver, Blood, GI Tract	2.3E+00		6.5E-03	2.3E+00
			Maganese					Maganese	CNS	1.7E+00		1.7E-01	1.9E+00

Total Risk Across Surface Soil	1.9E-05
Total Risk Across Groundwater	4.5E-06
Total Risk Across All Media and All Exposure Routes	2.4E-05

Total Hazard Index Across All Media and All Exposure Routes	7.2
Total Liver HI =	2.5E+00
Total CNS HI =	2.4E+00
Total Blood HI =	2.5E+00
Total Body Weight HI =	4.6E-01
Total Skin HI =	4.6E-02
Total Vascular HI =	4.6E-02
Total Lifetime HI =	1.9E+00
Total GI Tract HI =	2.4E+00
Total Kidney HI =	2.3E-02
Total Immune System HI =	3.8E-01
Total Lifespan HI =	9.9E-02

TABLE 2-15

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - FUTURE CHILD RESIDENT
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child (0-6 years)

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)anthracene	8.62E-07			8.6E-07	Benzo(a)anthracene					
			Benzo(a)pyrene	8.0E-06			8.0E-06	Benzo(a)pyrene					
			Benzo(b)fluoranthene	1.5E-06			1.5E-06	Benzo(b)fluoranthene					
			Dibenz(a,h)anthracene	3.4E-06			3.4E-06	Dibenz(a,h)anthracene					
			Indeno(1,2,3-cd)pyrene	5.3E-07			5.3E-07	Indeno(1,2,3-cd)pyrene					
			Aroclor-1254	1.3E-06		1.9E-06	3.2E-06	Aroclor-1254	Immunological, Nails	3.9E-01		5.6E-01	9.5E-01
			Aroclor-1260	1.8E-07		2.6E-07	4.4E-07	Aroclor-1260					
			Antimony					Antimony	Lifespan	7.4E-02		1.5E-01	2.2E-01
			Arsenic	5.9E-06		1.9E-06	7.8E-06	Arsenic	Vascular, Skin	1.5E-01		4.9E-02	2.0E-01
			Cadmium					Cadmium	Kidney	1.7E-02		3.4E-02	5.1E-02
			Iron					Iron	Liver, Blood, GI Tract	6.4E-02		6.4E-02	7.0E-01
			Maganese					Maganese	CNS	2.4E-01		8.2E-01	1.1E+00
Groundwater	Water /Air	Onsite	Acenaphthene					Acenaphthene	Liver	7.6E-02		1.4E-01	2.1E-01
			Carbazole	2.6E-06			2.6E-06	Carbazole					
			Dibenzofuran					Dibenzofuran		7.7E-01		1.3E+00	2.1E+00
			Fluorene					Fluorene	Blood	4.3E-02		1.1E-01	1.5E-01
			Naphthalene					Naphthalene	Body Weight	1.2E-01	1.1E+00	8.2E-02	1.3E+00
			Phenanthrene					Phenanthrene	Body Weight	5.8E-02	1.0E-01	1.2E-01	2.8E-01
			Iron					Iron	Liver, Blood, GI Tract	5.3E+00		1.1E-02	5.3E+00
			Maganese					Maganese	CNS	4.1E+00		2.7E-01	4.3E+00
						Total Risk Across Surface Soil	2.6E-05		Total Hazard Index Across All Media and All Exposure Routes				16.9
						Total Risk Across Groundwater	2.6E-06						
						Total Risk Across All Media and All Exposure Routes	2.8E-05						

Total Liver HI =	6.2E+00
Total CNS HI =	5.4E+00
Total Blood HI =	6.1E+00
Total Body Weight HI =	1.6E+00
Total Skin HI =	2.0E-01
Total Vascular HI =	2.0E-01
Total Lifetime HI =	4.3E+00
Total GI Tract HI =	6.0E+00
Total Kidney HI =	5.1E-02
Total Immune System HI =	9.5E-01
Total Lifespan HI =	2.2E-01

TABLE 2-16

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - COMMERCIAL WORKER
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

				Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
Medium	Exposure Medium	Exposure Point	Chemical	Ingestion	Inhalation	Dermal	Exposure Routes Total	Chemical	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)pyrene	1.3E-06			1.3E-06	Benzo(a)pyrene					
			Aroclor-1254	2.1E-07		1.4E-06	1.6E-06	Aroclor-1254	Immunological , Nails	1.5E-02		9.6E-02	1.1E-01
			Arsenic	9.4E-07		1.4E-06	2.3E-06	Arsenic	Vascular, Skin	5.9E-03		8.5E-03	1.4E-02
						Total Risk Across Surface Soil	5.2E-06					Total Hazard Index Across All Media and All Exposure Routes	0.13

Total Risk Across All Media and All Exposure Routes	5.2E-06

Total Immune System HI =	1.1E-01
Total Skin HI =	1.4E-02
Total Vascular HI =	1.4E-02

TABLE 2-17

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - COMMERCIAL WORKER - EXPOSURE TO SURFACE AND SUBSURFACE SOIL
SITE 46
NWSCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)pyrene	8.16E-07			8.2E-07	Benzo(a)pyrene					
		Subsurface Soil	Dibenz(a,h)anthracene	4.2E-07			4.2E-07	Dibenz(a,h)anthracene					
			Aroclor-1254	5.9E-08		3.8E-07	4.4E-07	Aroclor-1254	Immunological, Nails	4.2E-03		2.7E-02	3.1E-02
			Arsenic	1.6E-06		2.3E-06	3.9E-06	Arsenic	Vascular, Skin	9.8E-03		1.4E-02	2.4E-02
			Iron					Iron	Liver, Blood. GI Tract	3.8E-02		1.7E-02	5.5E-02
						Total Risk Across All Soil	5.5E-06				Total Hazard Index Across All Media and All Exposure Routes		0.11

Total Risk Across All Media and All Exposure Routes	5.5E-06
Total Liver HI =	5.5E-02
Total Immune System HI =	3.1E-02
Total Blood HI =	5.5E-02
Total Skin HI =	2.4E-02
Total Vascular HI =	2.4E-02
Total GI Tract HI =	5.5E-02

TABLE 2-18

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - FUTURE ADULT RESIDENT - EXPOSURE TO SURFACE AND SUBSURFACE SOIL
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Inhalation	Dermal	Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)anthracene	5.33E-07			5.3E-07	Benzo(a)anthracene					
		Subsurface Soil	Benzo(a)pyrene	2.2E-06			2.2E-06	Benzo(a)pyrene					
			Benzo(b)fluoranthene	6.3E-07			6.3E-07	Benzo(b)fluoranthene					
			Dibenz(a,h)anthracene	1.1E-06			1.1E-06	Dibenz(a,h)anthracene					
			Indeno(1,2,3-cd)pyrene	3.6E-07			3.6E-07	Indeno(1,2,3-cd)pyrene					
			Aroclor-1254	1.6E-07		1.3E-06	1.5E-06	Aroclor-1254	Immunological, Nails	1.2E-02		9.5E-02	1.1E-01
			Aroclor-1260	7.9E-08		6.4E-07	7.2E-07	Aroclor-1260					
			Antimony					Antimony	Lifespan	9.9E-03		1.2E-01	1.3E-01
			Arsenic	4.2E-06		7.7E-06	1.2E-05	Arsenic	Vascular, Skin	2.7E-02		5.0E-02	7.8E-02
			Chromium					Chromium	NOAEL	1.4E-02		3.2E-01	3.3E-01
			Iron					Iron	Liver, Blood. GI Tract	1.1E-01		6.2E-02	1.7E-01
			Maganese					Maganese	CNS	1.2E-02		2.3E-01	2.4E-01
			Nickel					Nickel	Decreased body/ organ weights	2.8E-03		4.0E-02	4.3E-02
			Vanadium					Vanadium	NOEL	5.2E-03		1.2E-01	1.2E-01
						Total Risk Across All Soil	1.9E-05					Total Hazard Index Across All Media and All Exposure Routes	1.2

Total Risk Across All Media and All Exposure Routes: 1.9E-05

Total Liver HI =	1.7E-01
Total CNS HI =	2.4E-01
Total Blood HI =	1.7E-01
Total Immune System HI =	1.1E-01
Total Skin HI =	7.8E-02
Total Vascular HI =	7.8E-02
Total Lifetime HI =	1.3E-01
Total GI Tract HI =	1.7E-01
Total Body Weight HI =	4.3E-02

TABLE 2-19

REASONABLE MAXIMUM EXPOSURE (RME)
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - FUTURE CHILD RESIDENT - EXPOSURE TO SURFACE AND SUBSURFACE SOIL
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child (0-6 years of age)

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk: Ingestion	Carcinogenic Risk: Inhalation	Carcinogenic Risk: Dermal	Carcinogenic Risk: Exposure Routes Total	Chemical	Non-Carcinogenic Hazard Quotient: Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Soil	Soil	Surface Soil	Benzo(a)anthracene	1.24E-06			1.2E-06	Benzo(a)anthracene					
		Subsurface Soil	Benzo(a)pyrene	5.1E-06			5.1E-06	Benzo(a)pyrene					
			Benzo(b)fluoranthene	1.5E-06			1.5E-06	Benzo(b)fluoranthene					
			Dibenz(a,h)anthracene	2.6E-06			2.6E-06	Dibenz(a,h)anthracene					
			Indeno(1,2,3-cd)pyrene	8.4E-07			8.4E-07	Ideno(1,2,3-cd)pyrene					
			Aroclor-1254	3.7E-07		5.3E-07	9.0E-07	Aroclor-1254	Immunological, Nails	1.1E-01		1.5E-01	2.6E-01
			Aroclor-1260	1.8E-07		2.6E-07	4.5E-07	Aroclor-1260					
			Antimony					Antimony	Lifespan	9.3E-02		1.9E-01	2.8E-01
			Arsenic	9.9E-06		3.1E-06	1.3E-05	Arsenic	Vascular, Skin	2.6E-01		8.2E-02	3.4E-01
			Chromium					Chromium	NOAEL	1.3E-01		5.2E-01	6.4E-01
			Iron					Iron	Liver, Blood, GI Tract	9.9E-01		1.0E-01	1.1E+00
			Maganese					Maganese	CNS	1.1E-01		3.7E-01	4.8E-01
			Nickel					Nickel	Decreased body/ organ weights	2.6E-02		6.5E-02	9.1E-02
			Vanadium					Vanadium	NOEL	4.8E-02		1.9E-01	2.4E-01
						Total Risk Across Surface Soil	2.6E-05		Total Hazard Index Across All Media and All Exposure Routes				3.4

Total Risk Across All Media and All Exposure Routes	2.6E-05

Total Liver HI =	1.1E+00
Total CSN HI =	4.8E-01
Total Blood HI =	1.1E+00

Recreational Users. The carcinogenic risk to a child recreational user from the ingestion of fish for the Central Tendency Exposure was less than USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$, and for the Reasonable Maximum Exposure was within the target risk range. HIs from the ingestion of fish were less than one for the Central Tendency Exposure and Reasonable Maximum Exposure. The carcinogenic risk to an adult recreational user from the ingestion of fish for the Central Tendency Exposure was within USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$, but Incremental Cancer Risk slightly exceeded the target range for the Reasonable Maximum Exposure scenario. These estimated Incremental Cancer Risks were primarily attributable to arsenic and 4,4' -DDT in fish tissue. HIs from the ingestion of fish exceed one for the Central Tendency Exposure and Reasonable Maximum Exposure, indicating that ingestion of noncarcinogens (iron, mercury, and thallium) in fish tissue may cause adverse health effects. The fish tissue concentrations used to quantify potential risks contain a high degree of uncertainty. The concentrations of chemicals in fish tissue are not actual measured values, but are estimated from surface water concentrations and published chemical-specific bioconcentration factors (BCFs). In addition, the surface water samples from which fish tissue concentrations are estimated were not collected in open water, but in marshy areas of Site 46 where fishing is not feasible because of the lack of sufficient water and the density of vegetation. The Chemicals of Concern of primary concern were not reported in samples collected in open water. Consequently, the risk estimated from fish consumption at Site 46 might be greatly overestimated and not representative of conditions at the site. HIs from ingestion of fish exceeded one for the Central Tendency Exposure and Reasonable Maximum Exposure, indicating that ingestion of fish may cause adverse health effects. Iron, mercury, and thallium were the primary contributors to this risk. However, the surface water samples from which fish tissue concentrations were derived were located in a marshy area of the site and these Chemicals of Concern were not detected in any surface water samples collected in open water.

Construction Worker. Total Incremental Cancer Risks for construction workers were less than $1x10^{-6}$ for the Central Tendency Exposure and Reasonable Maximum Exposure. HIs were greater than one, indicating potential for adverse health effects from exposure to PAHs and manganese in groundwater. PAHs have been overestimated by very conservative models that do not accurately reflect potential chemical intakes from groundwater at the site. Estimated risks due to exposure to manganese in groundwater may be attributable to natural conditions at Dahlgren.

Future Residents. Total Incremental Cancer Risks for future residents were within the target risk range. HIs exceeded one, indicating the potential for adverse health effects from exposure to dibenzofuran, naphthalene, iron, and manganese in groundwater and exposure to iron in soil. The elevated risk from dibenzofuran is mainly the result of exposure by dermal contact with groundwater. The risks from dermal exposure to groundwater were estimated by a USEPA model which tends to overestimate intakes of PAHs from water. Because this model (the Bunge Model) greatly overestimates the intake of PAHs, it is not accepted for use in all USEPA regions for evaluating dermal exposure from these chemicals from water.

It is, therefore, unlikely that the risks calculated for dermal contact with dibenzofuran in water reflect the actual risks from this chemical.

Naphthalene was identified as a risk driver for children mainly by inhalation while showering. This inhalation risk is based on modeled air concentrations (Foster and Chrostowski, 1987) rather than on measured air concentrations and, therefore, contains a significant amount of uncertainty. There is additional uncertainty in the inhalation risk from naphthalene because the RfC used to calculate the inhalation HQ contains an uncertainty factor of 3,000 because of database deficiencies in the study from which the RfC was derived. Furthermore, young children generally do not take showers and the evaluation of this receptor by the shower model is conservative but may not be appropriate. Therefore, the risks calculated for a child from exposure to naphthalene contain much uncertainty and overconservatism and are not indicative of an actual exposure situation.

Manganese and iron were identified as risk drivers in groundwater. Although the maximum concentrations of these constituents exceeded site-specific background levels, it has been shown that manganese and iron concentrations significantly exceeding risk based concentrations are naturally occurring in the regional groundwater. Therefore, site-specific risks calculated for exposure to manganese and iron may be overestimated. Furthermore, a National Center for Environmental Assessment (NCEA) provisional RfD is used to evaluate noncarcinogenic effects from exposure to iron. The provisional RfD for iron is based on a concentration needed to protect against a deficiency of iron rather than adverse effect levels. Therefore, there is some degree of uncertainty associated with the use of the RfD for iron.

Commercial Worker. Total Incremental Cancer Risks for commercial workers were within the target risk range. HIs were less than one.

Uncertainty Analysis

Risks for hypothetical future onsite residents are evaluated in the risk assessment to be conservative. However, the Site is not expected to be used for residential development in the future and its groundwater is not a likely source of drinking water.

Arsenic was identified as an important contributor to carcinogenic risk in soil and groundwater. The carcinogenicity of arsenic via ingestion is not confirmed by the available data. The preponderance of scientific information indicates that humans are capable of metabolizing arsenic to expedite its elimination from the body. Its elimination from the body obviously mitigates the possibility for arsenic to manifest carcinogenic effects. However, USEPA has proposed an oral unit risk factor that was used for all oral and dermal exposures to arsenic at this site. Because arsenic is selected as a COPC for various media at

Site 46 and is a significant risk driver in groundwater, the risks associated with this chemical may be overstated.

2.7.2 Environmental Evaluation

A baseline ecological risk assessment was prepared and presented in the FS, based on the results of several investigations associated with the RI and FS of Site 46. The objectives of the ecological risk assessment are to identify the ecosystems potentially at risk and to assess the nature of risk(s). The risk assessment is prepared by identifying the communities or populations that may be at risk in each habitat type existing on or near Site 46 and then evaluating the range of risk for each group.

Identification of Ecological COCs

Soil, surface water, and sediment data were initially screened in the RI. A systematic approach was used to identify a list of preliminary contaminants of concern (PCOC). The plants and animals used in the assessment for Site 46 were from both aquatic and terrestrial habitats. The maximum chemical concentration in each medium (surface soil, sediments, and surface water) was compared to USEPA Region III Biological Technical Assistance Group (BTAG) screening levels. In addition, maximum oral doses for each detected chemical were evaluated for several wildlife species, relative to reference doses. All detected chemicals underwent a screening using simple food chain models and estimates of potential effects on wildlife (aquatic and terrestrial receptors) from ingesting site contaminants. The risk screening produced 63 PCOCs including volatile organic compounds (VOCs), SVOCs, pesticides, PCBs, and metals.

Exposure Assessment

The Site is located 250 feet south of Stump Dump Road, adjacent to a small tributary of Gambo Creek in the central part of Mainside. It is roughly rectangular in shape; the southwest boundary is approximately 350 feet in length and borders or extends into the marsh bordering the tributary. The marsh is contiguous with the Gambo Creek salt marshes and begins a transition to freshwater at Site 46. This transitional flora includes plants characteristic of salt marsh (*Spartina patens, S. cynosuroides* [cordgrasses], and *Baccharis halimifolia* [groundsel tree]) and brackish to freshwater tidal marshes (*Typha angustifolia* [narrow-leaf cattail], *Hibiscus moscheutos* [marsh mallow], *Panicum virgatum* [switchgrass], *Myrica cerifera* [wax myrtle], and *Decodon verticillatus* [water willow]). The freshwater species become more abundant than the saltwater species just north of the Site. The stream flowing through the marsh near the Site is only a few centimeters deep, but is wide enough in spots to support many very small fish. The remainder of the landfill is bordered by a pine forest (mostly Virginia pine) to the north, bottomland hardwoods along the marsh to the south, and an uneven-aged mixture of pines and hardwoods to the east. The landfill area itself has hummocks and some low areas, indicating physical disturbance and possible subsidence. The area is a mixture of trees, shrubs, vines, and herbaceous growth, presumably as a result of being disturbed. Dominant trees include red maple, black cherry, and black locust. There is a small drainage depression along the northwest border. The Site elevation ranges from about 2 feet above mean sea level at the edge of the tributary to about 10 feet above mean sea level on the northeast side. Soils in the landfill are Tetotum fine sandy loam series with slopes from 0 to 6 percent. These soils are deep and moderately well drained.

Exposure to contaminants was expected for terrestrial plants and soil organisms adjacent to buried waste or transported contaminants. Likewise, aquatic plants and animals in the marsh sediment would be exposed to chemicals deposited in the marsh with waste or from transport. Soluble contaminants would cause aquatic life in the water column to be exposed. It is possible that wildlife could be exposed from contaminated prey items. This is considered likely only for chemicals known to accumulate in food chains. Because of the need to focus the baseline assessment on the most crucial chemicals, chemicals unlikely to accumulate in food chains were not considered to have complete pathways to vertebrate receptors (birds, mammals, and fish). In addition to contaminated prey, wildlife receptors may be exposed via incidental ingestion of soil and sediment, uptake through the skin, and inhalation of volatiles and entrained soil particles. Only incidental ingestion of soil or sediment was part of the food chain simulation used to estimate risks to plants and animals. Quantification of dermal uptake and inhalation pathways for wildlife is a task made very difficult by lack of information. These pathways are also typically thought to be unimportant and therefore were not used to estimate risks. Wildlife may also come into contact with contaminants present in surface waters by using them as a source of drinking water. However, exposure to contaminants via this route was not considered at Site 46 because the tidal waters found in the marsh are brackish.

Ecological Effects Assessment

Exposure may occur from direct contact with contaminated soil, water, and/or sediment and from ingestion of contaminated prey. Therefore, risks from impairment of growth, reproduction, or long-term survival of the following receptor groups were assessed for Site 46:

- Aquatic vegetation communities
- Sediment dwelling animal communities
- Fish communities
- Populations of birds feeding on aquatic organisms (such as clams)
- Populations of birds feeding on soil invertebrates (such as worms)
- Populations of carnivorous birds

- Populations of omnivorous birds
- Populations of carnivorous mammals
- Populations of omnivorous mammals
- Populations of mammals feeding on aquatic organisms
- Populations of mammals feeding on soil invertebrates (such as worms)
- Populations of herbivorous mammals
- Populations of terrestrial vegetation communities
- Populations of amphibians and reptiles

Each PCOC was subsequently evaluated for direct acute and chronic toxicity exposure in the baseline risk assessment presented in the FS. Acute toxicity guidelines included acute Federal Ambient Water Quality Criteria and secondary acute values for surface water, Effects Range-Median (ER-Ms) for sediment, and a soil criteria from the Netherlands in which hazardous concentrations cause harm to 50 percent of the animals tested. Chronic toxicity guidelines included chronic Federal Ambient Water Quality Criteria and secondary chronic values for surface water, Effects Range-Low (ER-L) for sediment, Oak Ridge National Laboratory (ORNL) soil Preliminary Remediation Goals (PRGs), and USEPA Region III BTAG screening levels for soil. Food chain toxicity was evaluated for terrestrial and aquatic receptors for all bioaccumulative PCOCs. Both No-Observed-Adverse-Effect-Level (NOAEL) and Lowest-Observed-Adverse-Effect-Level (LOAEL) doses were used in evaluating food chain exposures for birds and mammals. Risk to fish from concentrations in their tissue was determined by a low (five percent) and medium (50 percent) estimate of LOAEL data found in the literature.

Ecological Risk Characterization

Tables 2-20 through 2-24 present results of the ecological effects characterization for surface soil, surface water, sediment, terrestrial receptors, and aquatic receptors, respectively. These results are discussed in the following paragraphs.

For receptors that are directly exposed to contaminants in soil, water, or sediment, risk was characterized by comparing site concentrations to chronic and acute guidelines. This comparison is made by calculating a Hazard Quotient (HQ). A HQ is calculated by dividing the chemical concentration in the soil, surface water, or sediment by the selected criteria for the soil, surface water, or sediment. If HQs are greater than one, it indicates a potential for risk. For receptors that are exposed through the food chain, either estimated oral doses or body burdens were compared to toxicity reference values. Calculated contaminant doses for birds and mammals were compared to oral toxicity reference values, whereas body burdens for fish were compared to guideline concentrations. These comparisons were also considered with factors such as partial exposure to contaminated areas, variation in diet, and bioavailability of contaminants in drawing risk conclusions.

For plants and invertebrates in soil, risk levels were low to moderate for PAHs and PCBs, with hazard quotients ranging from less than 1 to 7 (Table 2-20). Acute risks from soil metals were acceptable (HQs < 1), while potential chronic risks were high for aluminum and iron, at hazard quotients of 118 and 61, respectively. Soil pHs at Site 46 ranged from 4.22 to 7.5 (Table 2-20) and sediment pHs ranged from 6.1 to 6.7 (Table 2-22), so aluminum and iron were unlikely to be in a bioavailable form. However, no biological data from the Site indicate how available any of the metals may be. Low to moderate chronic risks were implied for several other metals, with hazard quotients ranging from less than 1 to 9.1. Potential chronic risks were moderate to high for DDT, endosulfan, and endrin (HQs from 18 to 910), while acute pesticide risks were acceptable.

Only metals were a concern in surface water; HQs are generally high, especially for iron and aluminum (up to 253), which may not be very biologically available (Table 2-21). There are no data from the Site regarding the availability of surface water metals, or what fraction of the total concentration may be dissolved, colloidal, or complexed by organic ligands.

In sediment, risk levels from metals were generally low (Table 2-22), with only nickel associated with potentially unacceptable acute risk at two locations. However, there is a sizeable area in which two or more metals exceed chronic guidelines at each sampling location. The metals that exceed chronic guidelines in this area are cadmium, copper, lead, nickel, and zinc. Potential risks from PAHs and pesticides were more widespread, and chronic HQs (up to 255) were higher than acute HQs (up to 3.67).

For the vertebrate receptors, risk levels were mostly acceptable (Table 2-23). Low levels of potential risk to fish were seen for PAHs, dieldrinR, cadmium, and copper, with HQs based on the 5 percent Toxicity Reference Value ranging up to 4.17 (Table 2-24).

Of the 63 chemicals retained by the screening-level assessment, 27 were retained as COCs, based on a risk characterization that included comparison of exposure to guidelines, spatial analysis of contaminant concentrations; and the likelihood that the contaminant is in a form that could be used by plants and animals. Most of the potential risk is for receptors directly exposed to Site media (plants and invertebrates in soil, surface water, and sediment). PAHs, dieldrinR, cadmium, and copper are associated with low levels of food chain risk to fish, exceeding 5 percent Toxicity Reference Values by factors up to about 4. Several of the COCs have no toxicity data and many other COCs are associated with acceptable levels of risk. However, PAHs in sediment and metals in soil and surface water have moderate to high levels of potential risk for plants and invertebrates. Several metals occur together in sediment at levels that indicate potential chronic risk. To help inform decisions regarding whether the COCs require remediation, risk management issues are discussed in the Section 2.7.3.

TABLE 2-20

BASELINE ECOLOGICAL RISK ASSESSMENT
CHEMICALS OF CONCERN FOR DIRECT TOXICITY - SURFACE SOIL
SITE 46: JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

Chemical	Fre-quency of De-tec-tion	Range of Detection (mg/kg)		Mean (mg/kg)	Chronic Guidelines (mg/kg)		Maximum Chronic Hazard Quotients		Mean Chronic Hazard Quotients		Acute Guidelin e (mg/kg)	Maximu m Acute Hazard Quotient	Notes
		Min.	Max.		Prim.	Sec.	Prim.	Sec.	Prim.	Sec.			
Volatile Organic Compounds													
Acetone	1/11	0.01	0.01	0.01	NA	NA	NA	NA	NA	NA	NA	NA	
Semivolatile Organic Compounds													
2-Methylnaphthalene	6/19	0.027	0.24	0.087	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Acenaphthene	8/19	0.062	0.31	0.161	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Acenaphthylene	1/19	0.15	0.15	0.150	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Anthracene	8/19	0.071	0.56	0.248	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Benzo(a)anthracene	14/19	0.069	1.6	0.553	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Benzo(a)pyrene	15/19	0.05	1.9	0.483	0.7	NA	2.7	NA	0.69	NA	NA	NA	PAH
Benzo(b)fluoranthene	15/19	0.047	3.7	0.687	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Benzo(g,h,i)perylene	12/19	0.03	1.4	0.303	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Benzo(k)fluoranthene	9/19	0.046	0.98	0.363	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Carbazole	9/19	0.025	0.79	0.191	NA	NA	NA	NA	NA	NA	NA	NA	Occurs with PAHs
Chrysene	16/19	0.051	2.7	0.643	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Di-n-butyl phthalate	3/19	0.029	0.058	0.046	NA	NA	NA	NA	NA	NA	NA	NA	Phthalate
Di-n-octyl phthalate	3/19	0.045	0.092	0.076	NA	NA	NA	NA	NA	NA	NA	NA	Phthalate
Total phthalates	4/19	0.045	0.144	0.092	0.1	NA	1.44	NA	0.92	NA	60	0.002	Summed phthalates
Dibenz(a,h)anthracene	6/19	0.051	0.43	0.195	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Dibenzofuran	5/19	0.029	0.19	0.094	NA	NA	NA	NA	NA	NA	NA	NA	Occurs with PAHs
Fluoranthene	15/19	0.0695	2.9	0.902	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Fluorene	8/19	0.055	0.18	0.111	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Indeno(1,2,3-cd)pyrene	13/19	0.03	1.1	0.337	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Naphthalene	5/19	0.042	0.36	0.122	0.6	NA	0.60	NA	0.20	NA	NA	NA	PAH
Phenanthrene	14/19	0.052	3.1	0.720	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Pyrene	15/19	0.0855	3.6	1.080	NA	NA	NA	NA	NA	NA	NA	NA	PAH
Total PAH	16/19	0.269	19.56	5.744	1	NA	19.56	NA	**5.74**	NA	40	0.49	Summed PAHs

TABLE 2-20

BASELINE ECOLOGICAL RISK ASSESSMENT
CHEMICALS OF CONCERN FOR DIRECT TOXICITY - SURFACE SOIL
SITE 46: JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Fre-quency of De-tec-tion	Range of Detection (mg/kg)		Mean (mg/kg)	Chronic Guidelines (mg/kg)		Maximum Chronic Hazard Quotients		Mean Chronic Hazard Quotients		Acute Guideline (mg/kg)	Maximum Acute Hazard Quotient	Notes
		Min.	Max.		Prim.	Sec.	Prim.	Sec.	Prim.	Sec.			
Pesticides and PCBs													
4,4'-DDE	5/10	0.0042	0.25	0.042	NA	0.1	NA	2.5	NA	0.42	NA	NA	DDT metabolite
4,4'-DDT	7/10	0.0081	0.5	0.082	NA	0.1	NA	5.0	NA	0.82	NA	NA	
DDTR	7/10	0.0081	0.799	0.181	0.01	0.1	79.9	8.0	**18.1**	**1.81**	4	0.20	Summed DDE&T
Aroclor-1254	2/16	0.42	7	0.486	NA	0.1	NA	70.0	NA	**4.86**	1	**7.00**	
Aroclor-1260	2/16	0.26	0.32	0.057	NA	0.1	NA	3.2	NA	0.57	1	0.32	
Endosulfan II	5/10	0.0025	0.046	0.0091	0.00001	NA	4600.0	NA	**910**	NA	4	0.01	
Endrin ketone	2/11	0.0011	0.0028	0.0020	0.00004	NA	70.0	NA	**48.8**	NA	NA	NA	
Total 'drins	3/11	0.0003	0.0028	0.0014	0.005	NA	0.6	NA	0.28	NA	4	0.001	
Metals and Inorganic Compounds													
Aluminum	19/19	3390	12500	5889	50	1	250	12500	**118**	**5889**	NA	NA	
Antimony	5/19	0.62	3.5	1.506	3	0.48	1.17	7.3	0.50	**3.14**	15	0.23	
Beryllium	15/19	0.26	0.66	0.422	1.1	0.02	0.6	33.0	0.38	**21.11**	30	0.02	
Cadmium	6/19	0.17	3.9	0.677	0.8	2.5	4.88	1.6	0.85	0.27	12	0.33	
Chromium	19/19	5	18.1	10.18	64	0.008	0.28	2413	0.16	**1358**	230	0.08	
Copper	18/19	2.8	90.8	24.11	36	15	2.52	6.1	0.67	**1.61**	190	0.48	
Iron	19/19	5310	25300	12102	200	NA	127	NA	**61**	NA	NA	NA	
Lead	19/19	8.8	62.6	29.56	50	0.01	1.25	6260	0.59	**2956**	290	0.22	
Manganese	19/19	14.8	834	198.8	100	330	8.34	2.5	**1.99**	0.60	NA	NA	
Mercury	8/19	0.06	0.27	0.106	0.1	0.058	2.70	4.7	**1.06**	**1.82**	10	0.03	
Nickel	19/19	1.6	139	14.57	30	2	4.6	69.5	0.49	**7.28**	210	0.66	
Silver	1/19	0.26	0.26	0.189	2	1 E-05	0.13	26531	0.09	**19253**	15	0.02	
Vanadium	19/19	10.9	30.4	18.26	2	0.5	15.2	60.8	**9.1**	**36.5**	250	0.12	
Zinc	19/19	8.2	371	64.44	50	10	7.4	37.1	**1.29**	**6.44**	720	0.52	
Miscellaneous													
pH	10/10	4.22	7.54	5.950									

1 Lowest among guidelines for plants, earthworms, and soil microbial processes

NA - None Available

Items bolded indicate an HQ greater than 1.

TABLE 2-21

BASELINE ECOLOGICAL RISK ASSESSMENT
CHEMICALS OF CONCERN FOR DIRECT TOXICITY - SURFACE WATER
SITE 46: JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical	Frequency of Detection	Range of Detection (ug/L)		Mean (ug/L)	Chronic Guideline (Ug/L)	Maximum Chronic Hazard Quotient	Mean Chronic Hazard Quotient	Acute Guideline (ug/L)	Maximum Acute Hazard Quotient	Notes
		Min.	Max.							
Semivolatile Organic Compounds										
4-Methylphenol	1/16	2	2	2	13	0.15	0.15	230	0.01	
Dibenzofuran	1/16	2	2	2	3.7	0.54	0.54	66	0.03	
Pesticides and PCBs										
4,4'-DDT	1/4	0.008	0.008	0.008	0.013	0.62	0.62	0.13	0.06	
Endrin	1/4	0.00525	0.00525	0.00525	0.011	0.48	0.48	0.033	0.16	
Metals and Inorganic Compounds										
Aluminum	29/31	78	85400	22008	87	982	**253**	750	**114**	
Arsenic	20/31	1	64	16.124	36	1.78	0.45	69	0.93	
Cadmium	5/31	0.415	6.7	1.905	9.356	0.7	0.20	24.35	0.28	
Chromium	26/3l	1	145	33.316	11.4	12.7	**2.9**	16.29	**8.90**	Cr^{+6} assumed
Chromium	26/31	1	145	33.316	312	0.5	0.11	17759	0.01	Cr^{+3} assumed
Copper	27/31	2	252	58.21	3.73	67.5	**15.6**	5.78	**43.6**	
Iron	31/31	1080	1190000	117291	1000	1190	**117**	NA	NA	
Lead	27/31	0.5	755	94.045	8.52	89	**11.0**	221	**3.42**	
Manganese	31/31	42.7	3390	839.1	120	28	**7.0**	2300	**1.47**	
Mercury	27/42	0.036	355	42.591	0.906	392	**47**	1.647	**216**	Less reliable data
Mercury, low level	8/8	0.00449	0.1583	0.059	0.906	0.2	0.07	1.647	0.10	
Nickel	28/31	1	479	72.205	8.28	57.8	**8.72**	74.75	**6.41**	
Silver	11/31	0.5	38.1	3.345	0.224	170	**15**	2.24	**17.0**	
Zinc	27/31	3	1310	287.606	85.6	15.3	**3.4**	95.1	**13.8**	

NA = None Available
Items bolded indicate an HQ greater than 1.

TABLE 2-22

BASELINE ECOLOGICAL RISK ASSESSMENT
CHEMICALS OF CONCERN FOR DIRECT TOXICITY - SEDIMENT
SITE 46 - JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

Chemical	Frequency of Detection	Range of Detection (mg/kg) Min.	Range of Detection (mg/kg) Max.	Mean (mg/kg)	Chronic Guideline (mg/kg)	Maximum Chronic Hazard Quotient	Mean Chronic Hazard Quotient	Acute Guideline (mg/kg)	Maximum Acute Hazard Quotient	Notes
Volatile Organic Compounds										
1,1,2,2-Tetrachloroethane	1/8	0.028	0.028	0.026	1.83	0.02	0.01	6.3	0.004	
2-Butanone	3/8	0.026	0.08	0.044	42	0.002	0.001	720.	0.0001	
Acetone	1/8	1.4	1.4	0.338	4.5	0.31	0.08	84.	0.017	
Dibromochloromethane	1/8	0.012	0.012	0.012	NA	NA	NA	NA	NA	
Methylene Chloride	3/8	0.21	0.52	0.137	6.6	0.08	0.02	78.	0.007	
Semivolatile Organic Compounds										
2-Methylnaphthalene	1/17	0.19	0.19	0.19	0.07	2.71	**2.71**	NA	NA	
Acenaphthene	7/17	0.17	0.88	0.571	0.016	55.0	**35.7**	0.5	**1.76**	
Anthracene	7/17	0.094	1.1	0.571	0.0853	12.9	**6.7**	1.1	**1.00**	
Benzo(a)anthracene	9/17	0.155	3	1.031	0.261	11.5	**3.95**	1.6	**1.88**	
Benzo(a)pyrene	9/17	0.121	2.2	0.893	0.43	5.12	**2.08**	1.6	**1.38**	
Benzo(g,h,i,)perylene	8/17	0.2	1.4	0.591	NA	NA	NA	NA	NA	
Benzo(k)fluoranthene	9/17	0.115	2.9	0.982	NA	NA	NA	NA	NA	
Carbazole	5/17	0.16	0.53	0.324	NA	NA	NA	NA	NA	
Chrysene	9/17	0.195	2.9	1.1	0.384	7.55	**2.86**	2.8	**1.04**	
Dibenz(a,h)anthracene	3/17	0.13	0.61	0.357	0.0634	9.62	**5.63**	0.26	**2.35**	
Fluoranthene	9/17	0.515	5.6	1.694	0.6	9.33	**2.82**	5.1	**1.10**	
Fluorene	7/17	0.128	0.66	0.355	0.019	34.7	**18.7**	0.54	**1.22**	
Indeno(1,2,3-cd)pyrene	7/17	0.25	1.6	0.746	NA	NA	NA	NA	NA	
Naphthalene	2/17	0.098	0.61	0.354	0.16	3.81	**2.21**	2.1	0.29	
Phenanthrene	8/17	0.395	5.5	1.35	0.24	22.9	**5.63**	1.5	**3.67**	
Pyrene	9/17	0.605	5.3	1.728	0.665	7.97	**2.6**	2.6	**2.04**	
Total PAH	9/17	3.02	32.7	7.28	4.02	8.13	**1.81**	44.8	0.73	
Pesticides and PCBs										
4,4'-DDD	4/5	0.00027	0.018	0.0086	0.002	9.	**4.32**	0.02	0.90	
4,4'-DDE	3/5	0.0045	0.0067	0.004	0.0022	3.05	**1.83**	0.027	0.25	
4,4'-DDT	5/5	0.0004	0.0089	0.0049	0.001	8.9	**4.88**	0.007	**1.27**	
Total DDT	5/5	0.00048	0.0276	0.0156	0.00158	17.47	**9.87**	0.0461	0.60	
alpha-BHC	1/5	0.00093	0.00093	0.0009	NA	NA	NA	NA	NA	
beta-BHC	1/5	0.00019	0.00019	0.0002	NA	NA	NA	NA	NA	
gamma-BHC (lindane)	1/5	0.00038	0.00038	0.0004	NA	NA	NA	NA	NA	

TABLE 2-22

BASELINE ECOLOGICAL RISK ASSESSMENT
CHEMICALS OF CONCERN FOR DIRECT TOXICITY - SEDIMENT
SITE 46 - JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 2 OF 2

Chemical	Frequency of Detection	Range of Detection (mg/kg)		Mean (mg/kg)	Chronic Guideline (mg/kg)	Maximum Chronic Hazard Quotient	Mean Chronic Hazard Quotient	Acute Guideline (mg/kg)	Maximum Acute Hazard Quotient	Notes
		Min.	Max.							
Endosulfan II	1/5	0.01	0.01	0.0087	NA	NA	NA	NA	NA	
Endosulfan Sulfate	1/5	0.00049	0.00049	0.0005	NA	NA	NA	NA	NA	
Endrin	1/4	0.00063	0.00063	0.0006	0.00002	31.25	**31.25**	0.045	0.01	
Endrin Aldehyde	1/5	0.0041	0.0041	0.0041	0.00002	205.	**205.**	0.045	0.09	
Endrin Ketone	3/5	0.0037	0.0076	0.0051	0.00002	380.	**255.**	0.045	0.17	
Methoxychlor	1/5	0.026	0.026	0.026	NA	NA	NA	NA	NA	
Monuron	2/5	0.007	0.1015	0.025	NA	NA	NA	NA	NA	
Metals and Inorganic Compounds										
Aluminum	17/17	2540	11950	5934.3	15000	0.8	0.4	NA	NA	
Arsenic	11/17	1.4	18.9	6.185	7.5	2.52	0.82	70.	0.27	
Barium	16/17	22.9	62.7	43.965	NA	NA	NA	NA	NA	
Beryllium	3/17	0.5	1.8	0.655	1.14	1.58	0.57	NA	NA	
Cadmium	2/17	1.2	1.7	0.648	1.2	1.42	0.54	9.6	0.18	
Cobalt	14/17	1.1	26.6	8.43	NA	NA	NA	NA	NA	
Copper	16/17	4.7	49	21.75	28	1.75	0.78	270.	0.18	
Iron	17/17	5530	42300	20271	29400	1.44	0.69	NA	NA	
Lead	17/17	11	66.2	33.24	46.7	1.42	0.71	218.	0.30	
Manganese	17/17	17.8	238	86.779	433	0.55	0.2	NA	NA	
Mercury	6/17	0.13	0.49	0.254	0.15	3.27	**1.69**	0.71	0.69	Less reliable data
Mercury, Low Level	8/8	0.0294	0.1089	0.0773	0.15	0.73	0.52	0.71	0.15	More reliable data
Nickel	16/17	1.5	75.1	19.582	20.9	3.59	0.94	51.6	**1.46**	
Vanadium	17/17	11.3	53.9	24.8	36.9	1.46	0.67	NA	NA	
Zinc	17/17	16.3	358	95.9	150	2.39	0.64	410.	0.87	
Miscellaneous										
pH	8/8	6.1	6.7	6.3						

NA - None Available

If mean chronic hazard quotients or maximum acute hazard quotients are greater than 1, then they are bolded and considered COCs.

If maximum chronic hazard quotients are greater than 1, then further analysis was performed.

TABLE 2-23

HAZARD QUOTIENTS FOR TERRESTRIAL RECEPTORS
SITE 46: JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Ecological Contaminant of Concern	Shrew		Fox		Robin		Hawk		Raccoon	
	NOAEL HQ	LOAEL HQ	NOAEL HQ	LOAEL HQ	NOAEL HQ	LOAEL HQ	NOAEL HQ	LOAEL HQ	NOAEL HQ	LOAEL HQ
Semivolatile Organic Compounds										
Di-n-butl phthalate	4.68E-05	1.40E-05	7.97E-06	2.39E-06	5.08E-01	5.08E-02	4.16E-02	4.16E-03	1.02E-05	3.07E-06
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAH	**2.94E+00**	2.94E-01	5.44E-01	5.44E-02	**2.10E+00**	2.10E-01	2.84E-01	2.84E-02	6.67E-02	6.67E-03
Pesticides and PCBs										
DDTR	9.66E-02	1.93E-02	1.26E-01	2.52E-02	**1.13E+00**	1.13E-01	**1.17E+00**	1.17E-01	2.63E-03	5.26E-04
DieldrinR	1.66E-01	1.66E-02	6.74E-02	6.74E-03	5.57E-02	5.57E-03	1.83E-02	1.83E-03	1.15E-02	1.15E-03
Total PCB	**2.34E+00**	2.34E-01	**6.49E+00**	6.49E-01	**1.24E+00**	1.24E-01	**2.56E+00**	2.56E-01	3.87E-02	3.87E-03
Endosulfan, Total	8.81E-02	8.81E-03	4.93E-02	4.93E-03	1.71E-03	1.71E-04	7.71E-04	7.71E-05	1.80E-03	1.80E-04
Methoxychlor	1.30E-03	1.84E-04	7.30E-04	1.03E-04	NA	NA	NA	NA	1.19E-04	1.68E-05
Metals and Inorganic Compounds										
Arsenic	**1.58E+00**	1.58E-01	6.25E-02	6.25E-03	1.75E-01	5.83E-02	3.34E-03	1.11E-03	4.72E-01	4.72E-02
Cadmium	4.83E-01	4.83E-02	1.77E-02	1.77E-03	4.78E-01	3.47E-02	1.27E-02	9.22E-04	2.46E-02	2.46E-03
Chromium, trivalent	2.99E-04	2.99E-03	2.36E-05	2.36E-04	**1.62E+00**	3.23E-01	6.74E-02	135E-02	1.86E-05	1.86E-04
Chromium, hexavalent	2.50E-01	6.23E-02	1.97E-02	4.92E-03	NA	NA	NA	NA	1.55E-02	3.88E-03
Copper	2.03E-01	1.54E-01	3.62E-02	2.75E-02	1.11E-01	8.42E-02	9.39E-03	7.16E-03	6.58E-02	5.00E-02
Lead	3.28E-01	3.28E-02	2.76E-02	2.76E-03	**4.48E+00**	4.48E-01	2.04E-01	2.04E-02	2.06E-02	2.06E-03
Manganese	1.47E-01	1.47E-02	7.36E-03	7.36E-04	2.90E-02	2.90E-03	6.78E-04	6.78E-05	1.18E-02	1.18E-03
Mercury, inorganic	2.06E-02	2.06E-03	4.50E-04	4.50E-05	1.03E-01	5.16E-02	1.04E-03	5.22E-04	1.39E-03	1.39E-04
Mercury, methyl	6.44E-01	1.29E-01	1.41E-02	2.82E-03	**7.25E+00**	7.25E-01	7.35E-02	7.35E-03	4.34E-02	8.69E-03
Nickel	4.90E-02	2.45E-02	2.97E-03	1.49E-03	4.26E-02	3.08E-02	1.60E-03	1.16E-03	1.86E-03	9.28E-04
Selenium	**2.84E+00**	7.11E-01	6.46E-01	1.62E-01	2.93E-01	1.46E-01	3.37E-02	1.69E-02	1.50E-01	3.75E-02
Zinc	1.78E-01	8.89E-02	2.30E-02	1.15E-02	**3.10E+00**	3.43E-01	2.64E-01	2.93E-02	2.07E-02	1.04E-02

NA - Not Available
Items bolded indicate an HQ greater than 1.

TABLE 2-24

HAZARD QUOTIENTS FOR AQUATIC RECEPTORS
SITE 46: JULY 28,1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

	Mink		Kingfisher		Raccoon		Mummichog			
Ecological Contaminant of Concern	**NOAEL HQ**	**LOAEL HQ**	**NOAEL HQ**	**LOAEL HQ**	**NOAEL HQ**	**LOAEL HQ**	**TRV HQ5%**	**TRV HQ50%**	**NOAEL HQ**	**LOAEL HQ**
Sernivolatile Organic Compounds										
Di-n-butl phthalate	7.38E-05	2.22E-05	**1.10E+00**	1.10E-01	1.02E-05	3.06E-06	NA	NA	NA	NA
Total PAH	3.09E-01	3.09E-02	3.46E-01	3.46E-02	6.66E-02	6.66E-03	**1.38E+00**	**1.38E+00**	1.34	0.13
Pesticides and PCBs										
DDTR	1.81E-02	3.62E-03	5.48E-01	5.48E-02	2.62E-03	5.24E-04	2.26E-01	7.45E-03	NA	NA
BHC, Total	1.97E-02	1.97E-03	1.57E-03	3.90E-04	2.30E-03	2.30E-04	3.36E-04	3.36E-04	NA	NA
Endosulfan, Total	1.13E-02	1.13E-03	5.38E-04	5.38E-05	1.79E-03	1.79E-04	7.92E-01	5.09E-02	NA	NA
DieldrinR	6.08E-01	6.08E-02	5.40E-01	5.40E-02	1.14E-02	1.14E-03	**1.62E+00**	1.16E-01	NA	NA
Methoxychlor	9.56E-04	1.35E-04	NA	NA	1.18E-04	1.67E-05	1.52E-01	1.52E01	NA	NA
Monuron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Metals and Inorganic Compounds										
Arsenic	8.03E-01	8.03E-02	1.17E-02	3.90E-03	4.71E-01	4.71E-02	2.41E-02	9.88E-03	0.12	0.01
Cadmium	3.63E-02	3.63E-03	6.35E-02	4.60E-03	2.45E-02	2.45E-03	**4.17E+00**	1.59E-.01	NA	NA
Copper	5.43E-02	4.12E-02	2.27E-02	1.73E-02	6.57E-02	4.99E-02	**2.80E+00**	2.86E-01	NA	NA
Lead	7.22E-02	7.22E-03	2.38E-01	2.38E-02	2.06E-02	2.06E-03	2.15E-01	2.15E-01	NA	NA
Mercury, inorganic	2.39E-03	2.39E-04	9.43E-03	4.71E-03	1.39E-03	1.39E-04	1.77E-02	2.41E-03	0.04	0.0004
Mercury, methyl	7.46E-02	1.49E-02	6.63E-01	6.63E-02	4.33E-02	8.66E-03	1.77E-02	2.41E-03	0.04	0.0004
Zinc	3.36E-02	1.68E-02	9.39E-01	1.04E-01	2.06E-02	1.03E-02	8.01E-01	8.01E-01	NA	NA

NA - Not Available
Items bolded indicate an HQ greater than 1.

Uncertainty Analysis

Sources of uncertainty were evaluated for their effect(s) on the risk estimate of chemicals in a given medium. By identifying how some of the factors creating uncertainty affect the risk estimates, overall understanding of the risk assessment is enhanced. Factors contributing to uncertainties regarding the risk characterization of Site 46 are discussed in the following paragraphs.

The sampling of environmental media may not accurately represent the actual distribution of chemical concentrations at the site and in nearby habitats. For example, soil samples are typically taken near likely sources in depressions where contaminants entrained in runoff would accumulate. These practices tend to result in data with high contaminant concentrations therefore risks for the entire site are overestimated.

The bioaccumulation factors used in the food chain model may not be appropriate for Site 46. The bioavailability of contaminants in soil, surface water, and sediment at Site 46 is unknown for plants and invertebrates as well.

Toxicity thresholds are uncertain, although statistical treatments of the fish tissue data associated with effects in fish help to quantify the level of implied risk. In contrast, the avian and mammalian toxicity values were essentially the lowest numbers found that were appropriate. Although a conservative choice, the level of conservativeness is not quantified. There is uncertainty in the concentration guideline values, which could be quantified, for example, by analyzing the variability of effects values. For the fish tissue concentrations associated with effects in fish, the relationship of tissue levels to the effects is unknown. Although tissue concentrations and the effects are both consequences of exposure, there is no cause-and-effect relationship between tissue concentrations and the effects.

There are uncertainties in applying ecotoxicological information derived from one set of animals and compared with another set of animals and from the laboratory to the field.

The threshold values used in the ecological risk assessment reflect impacts to individual organisms. Impacts to populations, communities, and higher levels of ecological organization associated with Site 46 may not be as significant. For example, loss of individuals from small areas may not affect their populations or the larger community.

The quotient method permits the evaluation of risks associated with only a single exposure point contaminant concentration, whereas ecological receptors will actually be exposed to environmental media in which contaminant concentrations will vary spatially.

Chemical interactions contribute to uncertainty. It is possible that two or more contaminants may act on the same target organ(s), resulting in additive toxicity that may be underestimated by limiting the hazard analysis to separate chemicals. Also, synergistic and antagonistic reactions may occur among environmental contaminants, resulting in underestimates or overestimates of risk.

The source of contaminants may be uncertain; the level of this uncertainty varies by COC. With railroad ties, roofing shingles, and roofing tar disposed at Site 46, high PAH concentrations in sediment have an obvious source. Metal debris is also found in the landfill, and metal concentrations in surface soil and surface water are elevated. The source of pesticides at Site 46 may be widespread application of these chemicals throughout the base, which was known to have occurred in past decades. It is also possible that waste left at Site 46 contained pesticides. Lastly, there are no known sources in Site 46 for VOCs, but records for the disposal of these and other chemicals may have been misplaced or not made.

2.7.3 Ecological Risk Management

Comparisons between site concentrations and background levels were made to help decide if remediation is warranted for each COC. Dahlgren background values were used in all cases. Site 46 data appear to be similar to background values for dieldrinR, endosulfan, beryllium, chromium, manganese, and vanadium in surface soil. For sediment, site data for DDTR, barium, and cobalt are below background concentrations. Except for eliminating the lone pesticide COC in surface soil, background values had only a small effect on the remaining chemical groups and media.

To decide if remediation is warranted for any of the COCs, additional factors were considered. This was necessary because remediation may be costly and destructive to the existing environment. These factors included: the chemical's direct toxicity risk relative to co-located contaminants; the likelihood of food-chain risk relative to background; the chemical's status as a common laboratory contaminant; and the chemical's concentration relative to reported detection limits.

In surface soil, acetone was detected only once in 11 samples and it is a common laboratory contaminant. Carbazole and dibenzofuran do not have soil toxicity data, but they co-occur with PAHs. It is reasonable to assume that, if remediation of PAHs is needed, these compounds will also be remediated. For the above reasons, these chemicals were not considered for remediation. The risk assessment was used to justify remediation of PAHs, DDT, PCBs, cadmium, mercury and zinc in surface soil.

PAHs, cadmium, copper, lead, nickel, and zinc are a concern for the remediation of sediment. Dibromochloromethane was detected once at a low concentration and source materials at Site 46 are not known. Carbazole levels are well below the range of total PAHs. Although a potential risk, the pesticides are present at trace levels and are unlikely candidates for active remediation.

Surface water metals levels are high (see Table 2-21), and the elevated concentrations do not seem to come from sediment suspended during sampling. Surface water remediation is seldom considered in this situation, however remediation of the landfill (i.e., source removal) should benefit the water quality. Given the high potential risks associated with surface water metals, remediation of the landfill is justified.

A summary of the ecological risk management evaluation is provided in Table 2-25.

2.7.4 <u>Summary, Conclusions, and Recommendations</u>

Results of the human health risk assessment indicate that human health-based remediation is not required. However, results of the ecological risk assessment indicate that remediation of DDTR, PAHs, PCBs, cadmium, mercury, and zinc in surface soil is justified. Further, remediation of PAHs, cadmium, copper, lead, nickel, and zinc in sediment is also justified. It is expected that remediation of the landfill (e.g., control of the source materials) would reduce the high potential risks associated with surface water metals.

The response action selected in this ROD is necessary to protect the public health and/or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

2.8 REMEDIAL ACTION OBJECTIVES

Based on an evaluation of site conditions, risks, and legal requirements, remedial action objectives (RAOs) were identified to protect ecological receptors. The RAOs for Site 46 are summarized as follows:

- Protect ecological receptors from exposure (direct and indirect) to sediment contaminated with PAHs, cadmium, copper, lead, nickel, and zinc (see Table 2-26).

- Protect ecological receptors from exposure to surface soil contaminated with PAHs, DDT compounds, PCBs, cadmium, mercury, and zinc (see Table 2-26).

- Remove waste within groundwater in the vicinity of GW 47-1 to address PAHs contamination.

TABLE 2-25

ECOLOGICAL RISK MANAGEMENT
SITE 46: JULY 28, 1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

Chemical of Concern	Detection Frequency	Range of Detections		Site Mean	Mainside Background		Reme-diate?	Notes
		Min	Max		Max	Min		
Surface Soil (mg/kg)								
Acetone	1/11	0.01	0.01	0.01	ND	ND	N	Common laboratory contaminant
Carbazole	9/19	0.025	0.79	0.1914	ND	ND	N	Co-occurs with PAHs; low levels
Dibenzofuran	5/19	0.029	0.19	0.0938	ND	ND	N	Co-occurs with PAHs; low levels
Total PAH	16/19	0.269	19.56	5.744	ND	ND	Y	
DDTR	7/10	0.0081	0.799	0.181	0.013	0.0082	Y	
DieldrinR	3/11	0.00033	0.0028	0.0014	0.026	0.0099	N	Less than background
Total PCB	3/16	0.32	7	0.543	ND	ND	Y	
Total Endosulfan	5/10	0.0025	0.046	0.0091	0.022	0.0093	N	Not significantly different from background
Beryllium	15/19	0.26	0.66	0.42	1.20	0.42	N	Less than background
Cadmium	6/19	0.17	3.9	0.68	0.45	0.22	Y	
Chromium	19/19	5	18.1	10.18	17.0	8.80	N	Not significantly different from background
Manganese	19/19	14.8	834	198.8	629	85.4	N	Not significantly different from background
Mercury	8/19	0.06	0.27	0.11	0.07	0.053	Y	
Vanadium	19/19	10.9	30.4	18.3	33.4	16.3	N	Not significantly different from background
Zinc	19/19	8.2	371	64.4	39.1	17.1	Y	
Surface Water (micrograms/L)								
Aluminum	29/31	78	85400	22008	668	608	*	
Chromium	26/31	1	145	33.32	ND	ND	*	
Copper	27/31	2	252	58.21	2.7	2.4	*	
Iron	31/31	1080	1190000	117291	1800	1655	*	
Lead	27/31	0.5	755	94.05	ND	ND	*	
Manganese	31/31	42.7	3390	839.1	657	610	*	
Nickel	28/31	1	479	72.21	ND	ND	*	
Silver	11/31	0.5	38.1	3.345	ND	ND	*	
Zinc	27/31	3	1310	287.6	56.8	42.3	*	

TABLE 2-25

ECOLOGICAL RISK MANAGEMENT
SITE 46: JULY 28, 1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 2 OF 2

Chemical of Concern	Detection Frequency	Range of Detections		Site Mean	Mainside Background		Reme-diate?	Notes
		Min	Max		Max	Min		
Sediment (mg/kg)								
Dibromochloromethane	1/8	0.012	0.012	0.012	ND	ND	N	Trace level (reported DLs: .014-.091 mg/kg)
Carbazole	5/17	0.16	0.53	0.324	ND	ND	N	Co-occurs with PAHs; low levels
Total PAH	9/17	3.02	32.7	7.28	ND	ND	Y	
DDTR	5/5	0.00048	0.0276	0.0156	0.061	0.051	N	Less than background
BHC, Total	1/5	0.00061	0.00061	0.00061	ND	ND	N	Trace level (reported DLs: .00015-.024 mg/kg)
DieldrinR	5/5	0.000625	0.0076	0.004	ND	ND	N	Trace levels (reported DLs: .00018-.046 mg/kg)
Total Endosulfan	2/5	0.00049	0.01	0.0052	ND	ND	N	Trace levels (reported DLs: .00015-.046 mg/kg)
Methoxychlor	1/5	0.026	0.026	0.026	ND	ND	N	Trace level (reported DLs: .0015-.13 mg/kg)
Monuron	2/5	0.007	0.1015	0.025	0.009	0.007	N	Trace levels (reported DL: 0.01 mg/kg)
Barium	16/17	22.9	62.7	44.0	78.5	77.1	N	Less than background
Cadmium	2/17	1.2	1.7	0.648	0.39	0.29	Y	
Cobalt	14/17	1.1	26.6	8.43	40.1	39.5	N	Less than background
Copper	16/17	4.7	49	21.75	22.5	20.1	Y	
Lead	17/17	11	66.2	33.24	39.8	37.1	Y	
Nickel	16/17	1.5	75.1	19.6	34.3	30.5	Y	Potential acute risk at 2 locations
Zinc	17/17	16.3	358	95.9	234	206	Y	

ND = Not Detected

*Although surface water remediation is unlikely, it is important that remediation of soil or sediment ameliorates surface water conditions.

TABLE 2-26

SITE 46 REMEDIAL ACTION OBJECTIVES
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Chemical of Concern	Sediment (mg/kg)	Soil (mg/kg)
DDTR	0.033	1.0
Total PAH	3.3	1.0
Total PCB	0.083	0.814
Cadmium	3.5	0.8
Copper	33	Does not apply
Lead	43	Does not apply
Mercury	0.18	0.1
Nickel	23	Does not apply
Zinc	150	50

- Control/minimize migration of contaminants via surface water run-off and leaching into groundwater.

- Create additional wetlands to help compensate for wetland losses from remedial activities at Site 46 and other sites at NSWCDL, including Site 9.

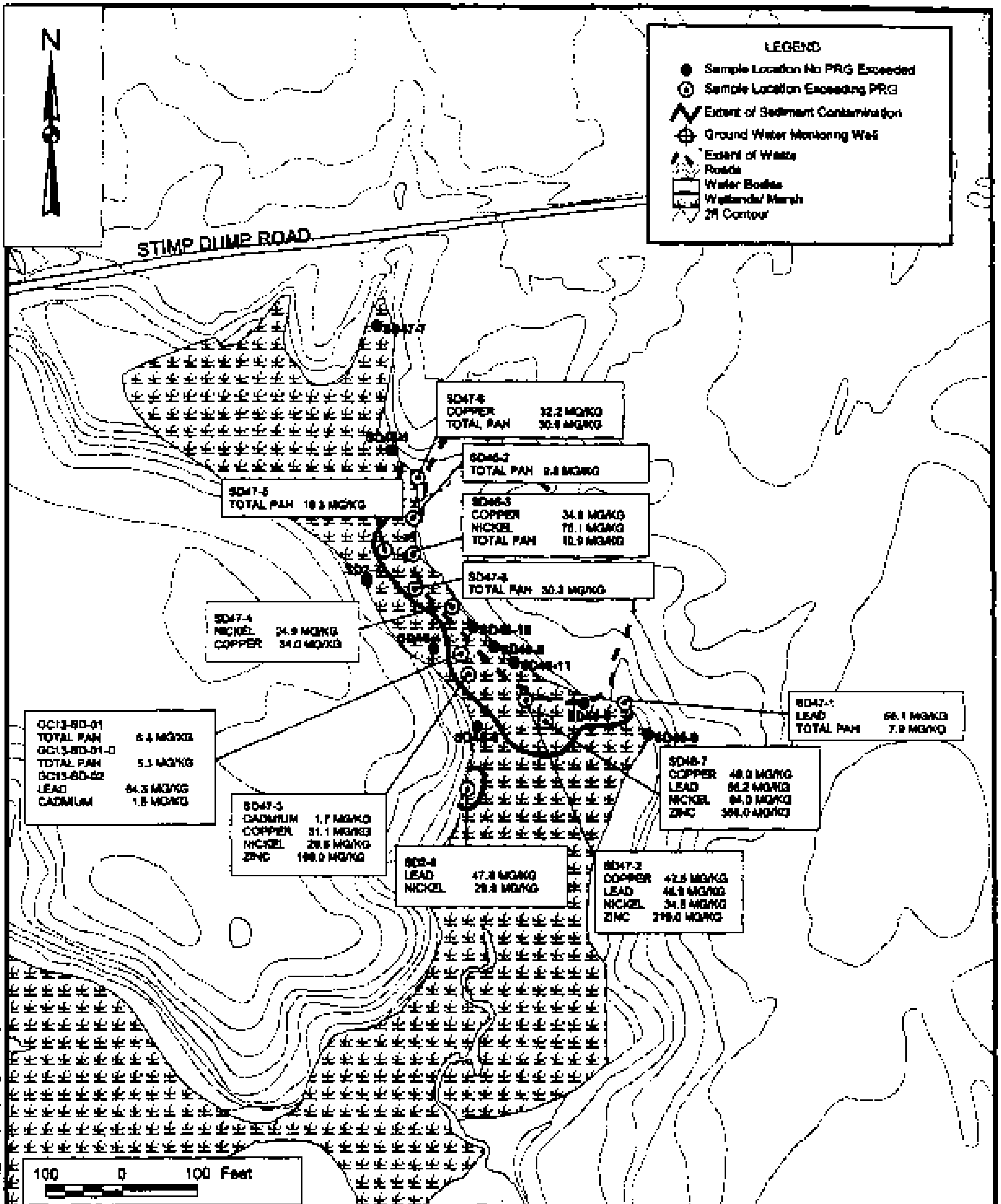
Based on a review of the literature and modeling involving site-specific data, Preliminary Remediation Goals (PRGs) were identified for the soil and sediment. Appendix C of the FS contains detailed information related to the development of site-specific ecological PRGs. Cross-media PRGs were also developed for Site 46. Cross-media PRGs are clean-up goals for chemicals in one medium (e.g., mercury in soil) that are designed to protect people, plants and animals if the chemicals migrate to another medium (e.g., if mercury migrates from soil to surface water). For purposes of the FS, PRGs for soil were developed for both the groundwater and surface water pathways. Appendix D of the FS details the development of cross-media PRGs for Site 46, including results of fate and transport modeling. The following figures show all surface water, sediment, and surface soil locations where chemical concentrations are greater than PRGs:

Figure 2-9	Sediment Samples Exceeding PRGs
Figure 2-10	Surface Soil Samples Exceeding PRGs
Figure 2-11	Groundwater Samples Exceeding PRGs

Since the FS was completed, sediment toxicity data collected from Gambo Creek have been evaluated to refine site-specific PRGs for sediment. These evaluations and PRGs are presented in a Technical Memorandum dated September 2001. These final PRGs now become the Remedial Action Objectives (cleanup goals) and are summarized in Table 2-26. The actual limits of excavation within the marsh will be based on pre-design sediment sampling.

2.9 DESCRIPTION OF ALTERNATIVES

A detailed analysis of the possible remedial alternatives for Site 46 was included in the Site 46 FS Report. This analysis was conducted in accordance with the USEPA document entitled Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA and the NCP.



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COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. Figure 2-9	REV 0

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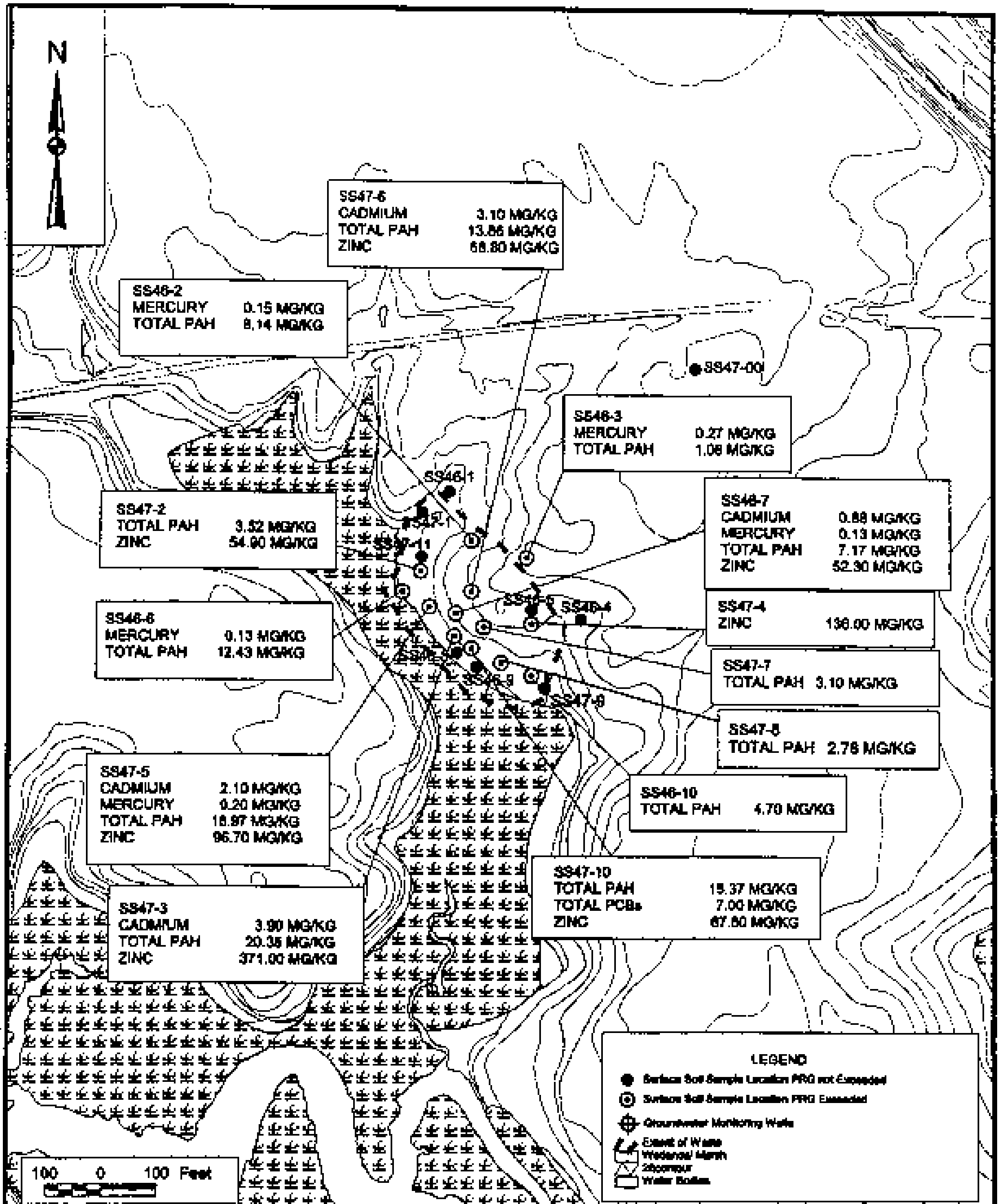

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COST/SCHEDULE AREA			APPROVED BY / DATE
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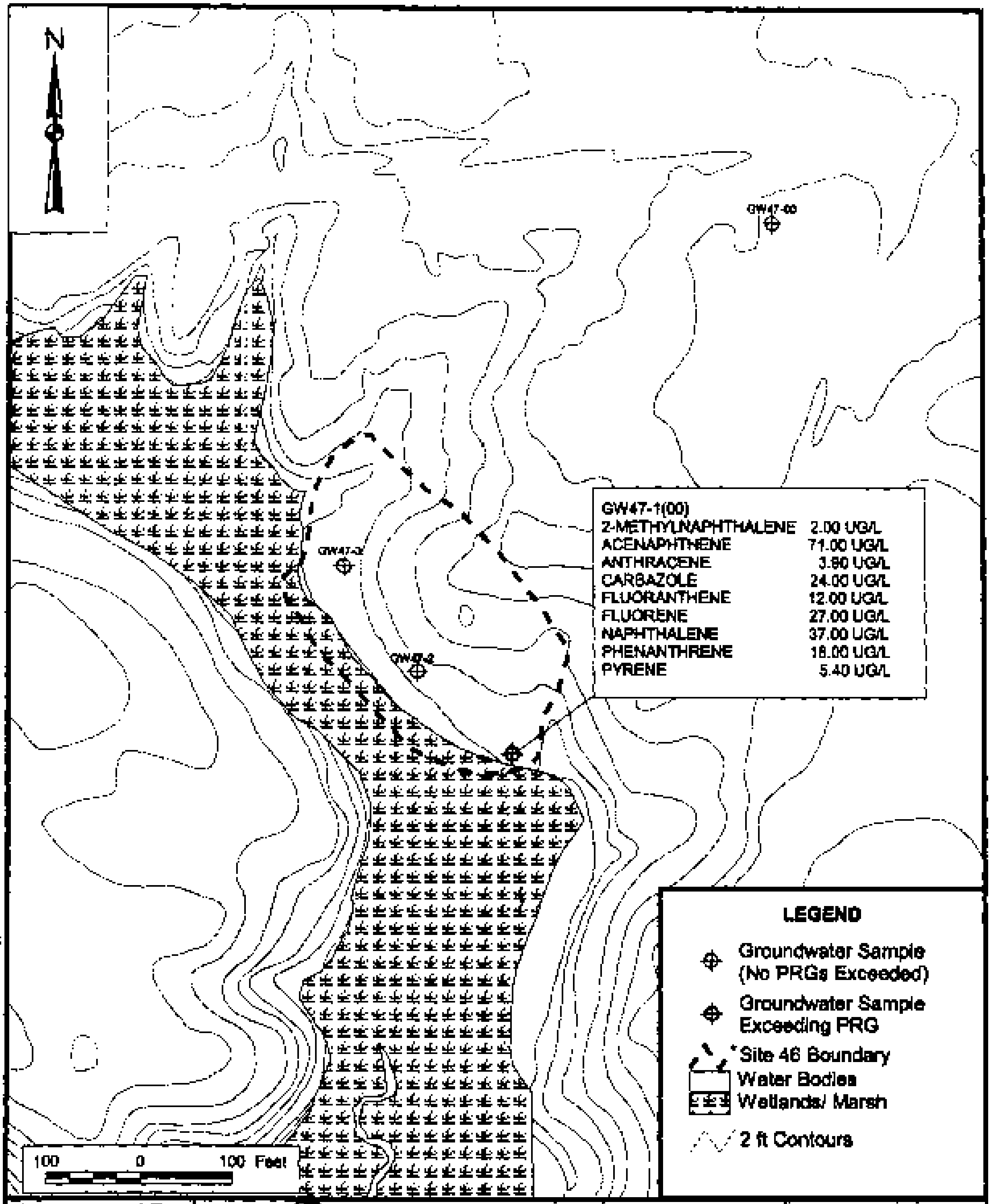

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COST/SCHEDULE-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. Figure 2-11	REV 0

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The remedial alternatives developed to address contamination associated with Site 46 and their expected outcomes are described below.

Alternative 1 - No Action

The No Action alternative is required to be evaluated under CERCLA. Under this alternative, no actions would be taken to reduce the toxicity, mobility, or volume of the contaminated media at Site 46. Alternative 1 serves as a baseline against which the effectiveness of other alternatives is measured. There are no costs associated with this alternative.

Alternative 2 - Complete Excavation with OffsIte Disposal and Wetlands Restoration

Alternative 2 would constitute closure of Site 46 with minimal, post-closure care. This alternative would consist of the following two components: (1) the excavation of waste (i.e., railroad ties, roofing debris, piping, etc.) and contaminated soils and sediments where chemical concentrations are greater than site-specific PRGs; and (2) site restoration. Figure 2-12 details the proposed area of excavation. An area of about 66,100 square feet, including the adjacent marsh, would be excavated to remove existing landfill waste. The depth of excavation is expected to average 4.3 feet, depending on the extent of visible waste. Based on the results from samples collected during the summer of 2000, excavation of additional sediments to a depth of 6 inches in the marsh may be required. This additional marsh area of excavation is approximately 21,100 square feet. Approximately 10,900 cubic yards of waste and contaminated soil and/or sediment will be excavated. The excavated materials will be transported to an appropriate offsite permitted landfill for final disposal.

Following excavation, the disturbed areas will be backfilled, graded, and revegetated as needed. Existing wetland areas that would be disturbed during construction will be restored as wetland areas. Along the west and southwest boundaries of Site 46, the remedial design will detail the establishment of grades, soil types, and vegetation to increase the wetland area. Grading and elevation requirements would be determined during the remedial design so the normal flow pattern of the creek would not be negatively impacted. Erosion protection may be required along portions of the marsh edge, and will be determined during design and approved in the design plan. It is estimated that an additional wetland area of approximately 1.2 acres can be established, as shown in Figure 2-11. The elevation of the new wetland area would range from an approximate elevation of 2 to 3 feet above mean seal level. Restoration of the existing marsh, disturbed during the excavation activities, would also be conducted. The approximate extent of the restored marsh area (Figure 2-13) is 0.4 acres. Wetland hydrology and establishment would be monitored for a minimum of 5 years, during spring and fall, with oversight provided by EPA. Corrective measures if needed to replace loss of vegetation from natural causes, such as drought, insects, and invasive plants would be implemented after agreement by the Navy, State and EPA.

Contaminant concentrations in groundwater at Site 46 would be lowered by removing all waste within and above the normal water table elevation. The removal of source material would eliminate the potential for future leaching and migration of contaminants. Based on previous trenching it is expected that the average depth of waste is 4.3 feet, and a significant portion of the wastes are periodically in contact with groundwater. Removal of the source of contamination and any contaminated soils/sediments should result in lower contaminant levels in adjacent surface water. Verification soil/sediment samples will be collected to confirm removal of any or all materials with contaminant levels exceeding Remedial Action Objectives. No long-term monitoring program is proposed for this alternative.

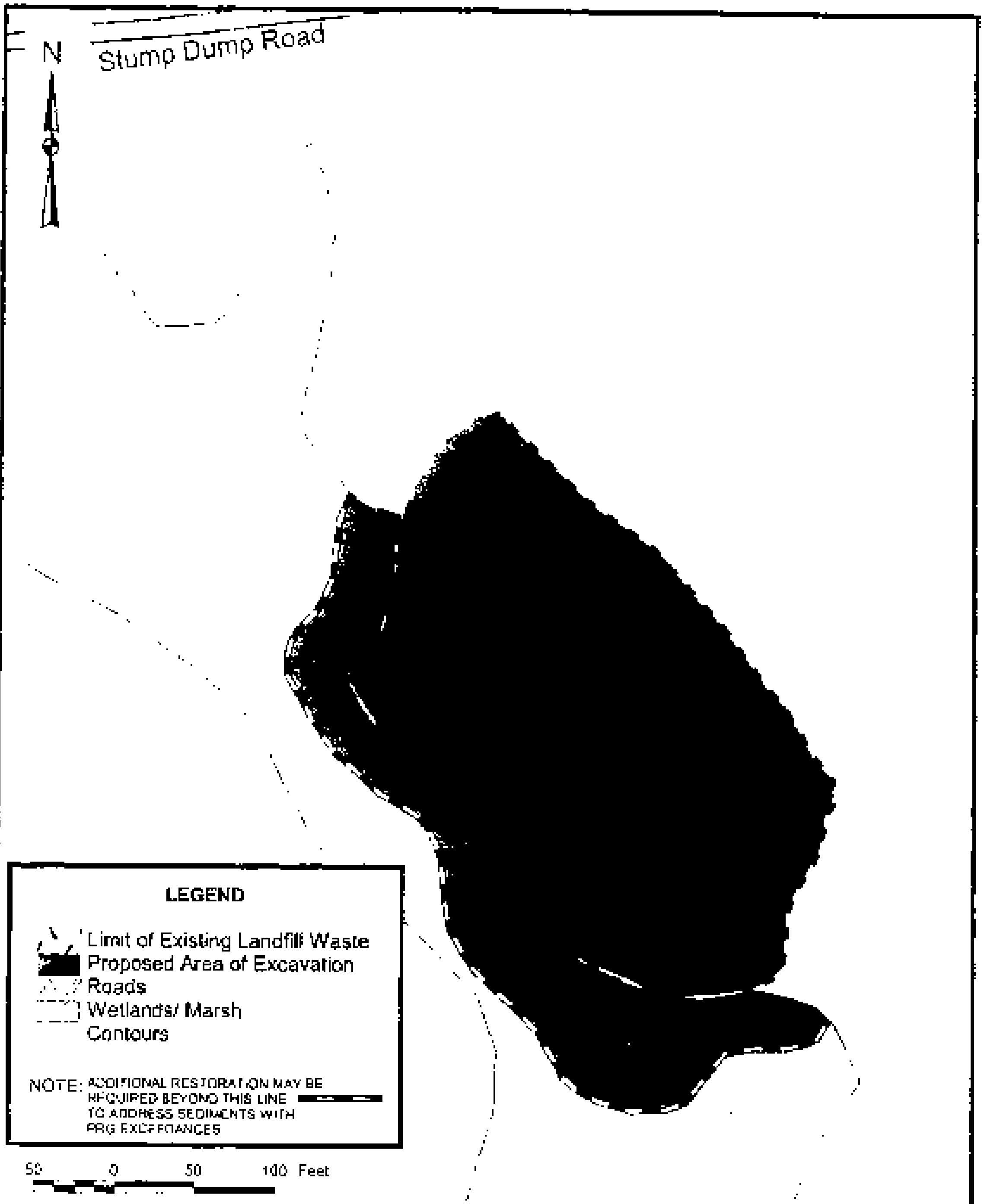
Implementation of Alternative 2 is expected to comply with Applicable or Relevant and Appropriate Requirements and “To Be Considered” (TBC), and would result in permanent reduction of the identified ecological risks.

The following costs are associated with Alternative 2:

Capital Cost ($):	$2,657,000
Operating/Maintenance (O&M) Cost ($/Yr):	$4,000 annually for five years
Total Present Worth ($):	$2,673,000
Time to Implement:	5 months

Alternative 3 - Partial Excavation, Cap System, Institutional Controls, Long-Term Monitoring, and Wetlands Restoration

- Partial Excavation - Contaminated sediment, soil, and waste would be excavated from the Gambo Creek tributary, adjacent marsh, and the landfill. The intent of the excavation is to remove accessible contaminated sediment from the marsh as well as waste present within 100 feet of the existing marsh. An area of approximately 35,300 square feet would be excavated to remove existing landfill waste. The depth of excavation would average approximately 4.3 feet. An additional area of approximately 8,700 square feet would be excavated to a depth of 6 inches to remove contaminated surface sediment. The excavated materials would be consolidated onsite and placed within the landfill footprint.



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COST/SCHEDULE AREA			APPROVED BY	DATE
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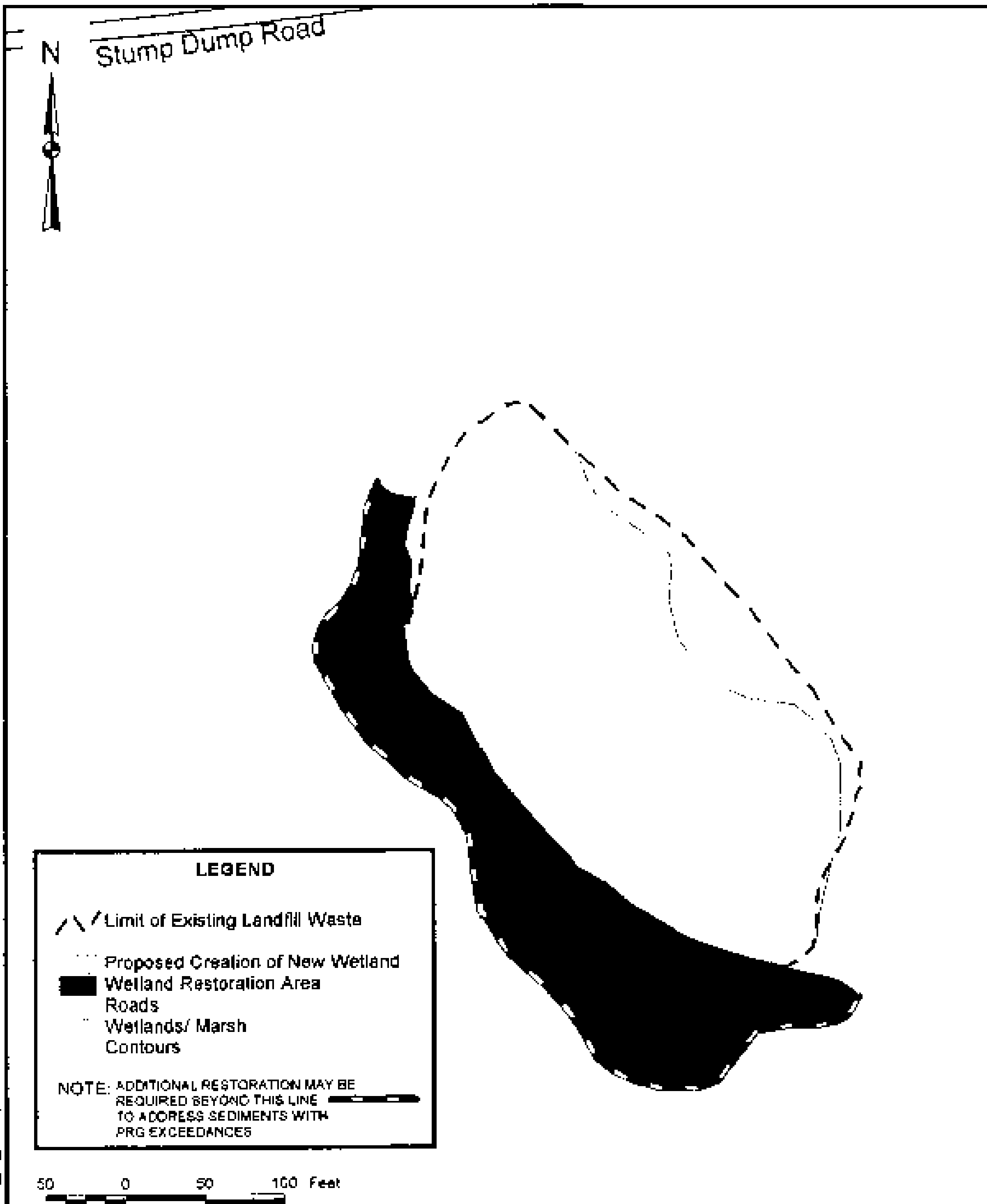

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SCALE: AS NOTED			DRAWING NO: Figure 2-13	REV: 0

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- Impermeable Cap System - A low-permeability (i.e., $1x10^{-5}$ cm/sec) cap system would be placed over the landfill area and cover of approximately 30,778 square feet. A soil cover would be placed over the low-permeability layer, the cover would be approximately 2 feet thick, consist of 18 inches of soil that is similar in physical and geologic properties to the existing uncontaminated soil adjacent to the site, and 6 inches of a vegetation-bearing topsoil. Between the low-permeability layer and cover soil, a drainage layer would be placed to direct runoff from the cap. Specific components and selection of final materials for the cap system would be determined during the remedial design. The capped area would be seeded with a perennial grass mixture suitable for the area. The area disturbed by excavation activities would be backfilled with an appropriate granular material, graded, and vegetated as appropriate.

- Wetland Restoration/Establishment - Along the west and southwest boundaries of Site 46, the remedial design will detail the establishment of grades, soil type(s), and vegetation to extend the present wetlands along the edge of the creek. Grade and elevation requirements would be determined during the remedial design to ensure that the normal flow pattern of the creek would not be negatively impacted and that the edge of the marsh would be at least 25 feet from the landfill edge. The 25-foot setback is intended to allow for the appropriate change in elevation from the marsh to the cap surface. Erosion protection may be required along portions of the marsh edge. It is assumed that additional wetland area can be established from an elevation of about 2 feet above mean sea level east to an approximate elevation of 5 above feet mean sea level. Based on this preliminary design, approximately 0.4 acres of additional wetland area would be constructed and 0.4 acres of existing wetland would be restored. Wetland hydrology and establishment would be monitored for a minimum of 5 years, using spring/fall inspections with oversight provided by EPA. Corrective measures if needed to replace loss of vegetation from natural causes, such as drought, insects, and invasive plants would be implemented after agreement by the Navy, State, and EPA.

- Institutional Controls and Long-Term Monitoring - Records of the landfill location, dimensions, and primary contamination would be placed in the NSWCDL Master Plan to prevent future site development for residential use. Access to the site would be restricted to prevent intrusion into the soil cover and liner. In the event of the sale of this property to private land developers, the deed would carry a restriction on the use of Site 46. Groundwater at the site is not currently used and is unlikely to be used within the foreseeable future under the Navy's ownership. Groundwater, surface water, and sediment samples would be collected bi-annually for the first 5 years following closure

- and then annually for years 6 through 30. This data would be used to assess the extent and migration of site-related contaminants and risks to human health and the environment. A report on site conditions would be issued every 5 years, per CERCLA regulations. The Navy would be responsible for implementing, monitoring, maintaining and enforcing the institutional controls.

Alternative 3 would comply with certain action-specific criteria including Commonwealth of Virginia Erosion and Sediment Control Regulations (applicable to design and implementation of the excavation work and cap system), and Commonwealth of Virginia Ambient Air Quality Standards (applicable to dust emission controls during excavation and placement of waste). Alternative 3 may not comply with all aspects of the Commonwealth of Virginia Industrial Waste Disposal Facilities standards. The cap system would be designed and constructed to meet the minimum hydraulic conductivity requirement of 1×10^{-5} cm/sec and would meet requirements for minimum thicknesses of the infiltration and erosion layer, including side slope percentage (i.e., 33%). However, some uncontrolled leachate may be generated if groundwater comes in contact with the landfilled wastes. Restoration and/or construction activities in wetland areas would comply with applicable Protection of Wetlands and Floodplains, applicable Wetlands Policy requirements of the Commonwealth of Virginia, and relevant Clean Water Act criteria/requirements. Based on 2000 sampling results using the low-flow sampling technique, existing groundwater concentrations are in compliance with applicable primary MCLs and Action Limits. Under Alternative 3, it is expected that groundwater concentrations would comply with applicable contaminant-specific ARARs for drinking water aquifers, provided that groundwater concentrations do not increase. However, current groundwater levels exceed the Remedial Action Objectives outlined in Section 2.8 for protection of surface water and sediment. The proposed long-term monitoring program would provide information as to whether or not Remedial Action Objectives are being met following implementation of the remedial measures. Given the presence of the cap, soil Remedial Action Objectives are expected to be met under Alternative 3. The proposed monitoring would provide information to determine whether surface water and sediment Remedial Action Objectives are being met after implementation of Alternative 3.

The following costs are associated with Alternative 3:

Capital Cost ($):	$1,483,000
Operating/Maintenance (O&M) Cost ($/Yr):	$54,000 annually for five years $10,000 additional 5th year for CERCLA review $26,200 annually in years 6 thru 30, $10,000 additional cost every 5 years for review required by CERCLA

Total Present Worth ($): $1,943,000

Time to Implement: 4.5 months

Alternative 4 - Partial Excavation, Cap System, Partial Cutoff Wall, Institutional Controls, Long-Term Monitoring, and Wetlands Restoration

Under this alternative the following measures would be taken:

- Partial Excavation - This component would be identical to that of Alternative 3.

- Impermeable Cap System - This component would be identical to that of Alternative 3.

- Partial Cutoff Wall - A soil-bentonite slurry wall would be constructed along the upgradient perimeter of the landfill. The purpose of the cutoff wall is to create a low-permeability (i.e., 1 X 10^{-6} cm/sec) barrier along the upgradient edge of the capped landfill to reduce the amount of groundwater coming in contact with the landfill. Groundwater upgradient of the wall would be diverted around the landfill before exiting into and/or beneath the unnamed tributary to Gambo Creek. Engineering details for the wall would be determined during the remedial design; however, it has been assumed that a 24-inch-wide wall would be constructed. It is expected that the wall would be keyed into an underlying clay/silty clay layer located beneath the site at an approximate depth of 15 feet. The impermeable cap system would extend over the top of the wall so that leakage (i.e., infiltration) along this interface would be minimized. Groundwater flow modeling would need to be done during the remedial design to obtain data regarding the change in groundwater flow direction upgradient and side-gradient of Site 46, and the change in normal groundwater levels inside, outside, and adjacent to Site 46. Flow modeling would be conducted as part of the remedial design and used to support the design details.

- Wetland Restoration/Establishment - This component would be identical to that of Alternative 3.

- Institutional Controls and Long-Term Monitoring - This component would be identical to that of Alternative 3.

Alternative 4 would comply with certain action-specific criteria, including Commonwealth of Virginia Industrial Waste Disposal Facility Standards relevant to final closure cover requirements for the cap system. The intent of the cap system and partial cutoff wall is to minimize the amount of water (i.e., surface water, groundwater, etc.) in contact with buried waste. However, some uncontrolled leachate may be generated if groundwater comes in contact with the landfilled wastes. Long-term monitoring data would be available to determine if compliance is occurring. Commonwealth of Virginia Erosion and Sediment Control Regulations apply to design and implementation of the excavation work and construction of the cap system and cutoff wall, and Commonwealth of Virginia Ambient Air Quality Standards apply to dust emission controls during excavation and placement of waste materials. Restoration of wetland areas would comply with applicable Protection of Wetlands and Floodplains, applicable Wetlands Policy requirements of the Commonwealth of Virginia, and relevant Clean Water Act criteria/regulations.

Based on the 2000 sampling event using low-flow sampling techniques, groundwater concentrations did not exceed any primary MCLs or Action Limits. Under Alternative 4, groundwater concentrations should not exceed applicable ARAR criteria for drinking water aquifers, if those concentrations do not increase. However, existing groundwater concentrations do exceed site-specific Remedial Action Objectives that were developed for groundwater to be protective of surface water and sediment. Long-term sampling and analyses would provide the necessary data to determine whether groundwater Remedial Action Objectives would be met following implementation of Alternative 4.

Under Alternative 4, soil Remedial Action Objectives are expected to be met because of the placement of an impermeable cap over the landfilled wastes and contaminated surface soil. The long-term monitoring program would provide the data needed to determine whether surface water and sediment Remedial Action Objectives are being met after implementation of Alternative 4.

The following costs are associated with Alternative 4:

Capital Cost ($):	$1,831,000
Operating/Maintenance (O&M) Cost ($/Yr):	$54,000 annually for five years $10,000 additional 5th year for CERCLA review $26,200 annually in years 6 thru 30, $10,000 additional cost every 5 years for review required by CERCLA
Total Present Worth ($):	$2,229,000
Time to Implement:	6 to 8 months

2.10 SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives described in Section 2.9 were evaluated in the FS against nine criteria identified in the NCP, as presented below and summarized in Table 2-27.

2.10.1 <u>Threshold Criteria</u>

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether or not each alternative provides adequate protection of human health and the environment and also describes how risks posed through each exposure pathway would be eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

Of all the alternatives, Alternative 2 would be the most protective because contaminated soils, sediments, and the source materials (i.e., wastes) would be removed from the site and sent to a permitted offsite facility for final disposal. Alternative 4 provides more overall protection than Alternative 3 because less groundwater would flow through the landfill and the resulting migration of contaminants would therefore be significantly reduced.

Both Alternatives 3 and 4 eliminate the pathway for exposure to surface soil by potential ecological receptors through construction of an low-permeability cap and the implementation of institutional controls. Alternative 1 would not be protective because there would still be the potential for receptors to be exposed to contaminants in the waste, surface soils, groundwater, and sediments. Alternative 1 would not meet the threshold criteria of protecting the environment.

Compliance with ARARs and TBCs

Section 121(d) of CERCLA and NCP §300.430(f)(1)(I)(B) require that remedial actions at CERCLA sites, at a minimum, attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting

TABLE 2-27

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES
SITE 46: JULY 28, 1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

Criteria for Comparative Analysis	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Overall Protectiveness	Not protective of potential ecological receptors.	Most protective of potential receptors. Wetland Gain = 1.2 acres.	Protective of potential receptors. Wetland Gain = 0.4 acres.	More protective of potential receptors than Alternative 3. Wetland Gain = 0.4 acres.
Compliance with ARARs	Does not comply with chemical-specific ARARs	Complies with chemical-specific, location-specific, and action-specific ARARs.	Complies with location-specific, chemical-specific ARARs; monitoring to determine if complies with action-specific ARARs.	Same as Alternative 3.
Long-term Protectiveness	No long-term reliability or performance	Most reliable and permanent because waste materials and contaminated soils/sediments at levels higher than PRGs would be excavated and disposed offsite in permitted landfill.	Potentially reliable and permanent if cap and institutional controls are maintained.	Potentially more reliable and permanent than Alternative 3 if cap, cutoff wall, and institutional controls are maintained.
Reduction of Toxicity, Mobility, or Volume Through Treatment	None	Provides most reduction in mobility because wastes and contaminated media removed from site and disposed in permitted landfill.	Provides some reduction in mobility resulting from partial excavation of wastes and contaminated sediments and construction of impermeable cap over landfill.	Provides more reduction in mobility than Alternative 3 because of cutoff wall that prevents groundwater from coming in contact with majority of wastes.
Short-term Effectiveness	None	Potential for exposure to contaminants greatest but can be adequately controlled. Five months to implement	Potential exposure concerns can be adequately controlled. Four and one half months to implement.	Potential for exposure to contaminants may be greater than Alternative 3, however, concerns can be adequately controlled. Four and one half months to implement.
Implementability	Easily Implementable	Easier to implement than Alternatives 3 and 4 as no cap or cutoff wall involved, however, greater amount of excavation required.	Easier to implement than Alternative 4, as no cutoff wall excavation is required. Extent of excavation is less than Alternative 2.	Most difficult to implement.
Cost	None	Capital: $2,657,000 O & M: $4,000 Total Present Worth: $2,673,000	Capital: $1,483,000 O & M: $54,000 Total Present Worth: $1,943,000	Capital: $1,831,000 O & M: $54,200 Total Present Worth: $2,290,00

laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those standards that are identified by a State in a timely manner and that are more stringent than Federal requirements may be applicable. Relevant and appropriate requirements are those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal or State environmental or facility siting laws. Although these requirements are not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, they do address problems or situations similar to those encountered at a CERCLA site. Their use is well-suited to the particular site. Only those State standards that are identified in a timely manner, and are more stringent than Federal requirements, may be relevant and appropriate.

Compliance with ARARs addresses whether or not a remedy will meet all applicable or relevant and appropriate requirements of other Federal and State environmental statutes, or provides a basis for invoking a waiver.

Alternative 2 would comply with applicable chemical-specific, location-specific, and action-specific ARARs because the source of contamination (i.e., waste) and contaminated media would be removed from the site, providing for "clean" closure of the site. Alternatives 3 and 4 would comply with applicable location-specific and action-specific ARARs, but may not comply with applicable chemical-specific ARARs, if groundwater contaminant levels were to increase over the 2000 sampling event levels. Under Alternatives 3 and 4, waste would likely remain in contact with groundwater. Alternative 1 would probably not comply with the chemical-specific ARARs, if groundwater contaminant levels were to increase over the 2000 sampling event levels.

2.10.2 <u>Primary Balancing Criteria</u>

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

None of the alternatives would reduce toxicity or volume of waste through treatment because no treatment is proposed. Alternative 2 would provide the highest degree of reduction in the mobility of contaminants present in the landfill, surface soils, and sediments, as they would be removed from the site and disposed of in a permitted landfill facility. Alternative 3 would reduce the mobility of contaminants present in the sediments and waste along the west and southwest boundaries of the landfill by removing them and placing them under an impermeable cap constructed over the remaining portion of the landfill. However, wastes would continue to be in contact with groundwater and leachate generation would potentially occur.

Alternative 4 would enhance the ability of the cap to reduce the mobility of contaminants because the proposed cutoff wall would prevent or reduce groundwater from coming into contact with waste buried in the landfill and thereby reduce the potential for leachate generation. Alternative 1 would provide no reduction in the mobility of waste contaminants because no remedial measures are proposed.

Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refer to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, after clean-up levels have been met. This criterion includes the consideration of residual risk that would remain onsite following remediation, and the adequacy and reliability of controls.

Alternative 2 would be the most effective and permanent remedy because all waste, soil, and sediments contaminated at levels exceeding the site-specific PRGs would be excavated from the site and disposed in a permitted offsite landfill. Alternative 4 would be very effective over the long term, because waste and contaminated soil and sediment would be excavated from the 100-foot setback area (including the marsh) and placed under an impermeable cap that would be contained on the upgradient side with a low- permeability cutoff wall. Alternative 3 would provide some degree of long-term effectiveness because excavation of wastes and contaminated media (from the same areas as under Alternative 4) and placement under the cap is proposed. Alternative 3 would be less effective than Alternative 4, however. Alternative 1 would not be effective over the long term because it does not protect the environment.

Short-term Effectiveness

Short-term effectiveness addresses which alternative can be implemented most quickly, and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until clean-up levels are achieved.

Of the action alternatives, Alternative 2 could be implemented the quickest. All alternatives, except Alternative 1, involve excavation within the marsh and open water-way, which results in short-term exposure and potential releases of contaminants to the environment, onsite workers, and possibly NSWCDL personnel; however, it is expected that these would or could be overcome through the use of engineering controls. Alternative 2 includes off-Base transport of the excavated contaminated materials that may result in short-term exposure and potential release of contaminants to the community. The amount of disturbance to the adjacent marsh and wetland areas is the same for Alternatives 2, 3, and 4. Alternative 4 would take the longest time to implement.

Implementability

Implementability addresses the technical and administrative feasibility of a remedy, from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Alternative 1 requires no implementation. Alternative 2 would be easier to implement than Alternatives 3 and 4 because it does not involve construction of the cap or a cutoff wall. Alternative 2 does require a greater volume of waste to be excavated, but requires fewer equipment changes and trained workers. Alternative 4 would be the most difficult to implement because it includes the construction of a cutoff wall that would require special equipment and materials (i.e., long-stick, back-hoe, and bentonite). However, all alternatives that involve removing waste, soils, or sediments present common implementability issues that can be overcome.

Cost

No costs are involved with the implementation of Alternative 1. Alternative 3 is the least costly action alternative. When comparing total present worth costs, Alternative 4 is 18 percent higher than Alternative 3, whereas Alternative 2 is 38 percent higher than Alternative 3. Total present worth costs for Alternative 2 are 17 percent higher than Alternative 4.

When comparing annual operation and maintenance costs for the first year, Alternative 2 costs are $4,000, whereas Alternatives 3 and 4 costs are both $54,000.

One goal of the Site 46 remedial action is to provide for wetlands mitigation to compensate for wetland losses resulting from the remediation of Site 9. The benefit provided by each alternative is summarized in Table 2-28.

2.10.3 Modifying Criteria

State Acceptance

The Virginia Department of Environmental Quality, on behalf of the Commonwealth of Virginia, has reviewed the information available for this site and concurs with this ROD and the selected remedy. A copy of the concurrence letter from the Commonwealth of Virginia is attached as Appendix A.

TABLE 2-28

COMPARATIVE ANALYSIS OF WETLANDS BENEFITS PROVIDED BY EACH ALTERNATIVE NSWCDL, DAHLGREN, VIRGINIA

Criteria for Comparison of Wetlands Benefits	Alternative 1	Alternative 2	Alternative 3	Alternative 4
New Wetland Area Created	None	1.2 acres	0.4 acres	0.4 acres
Construction Costs Avoided for Wetland Creation Elsewhere at NSWCDL[1]	None	$60,000	$20,000	$20,000

1 Based on a construction cost of $50,000 per acre.

Community Acceptance

Community acceptance summarizes the public's general response to the alternatives described in the Proposed Plan and the FS. No written comments were received during the 30-day comment period that began on July 20, 2001 and ended on August 20, 2001. A transcript of the public meeting is presented in Appendix B.

2.11 THE SELECTED REMEDY

Alternative 2, complete excavation with offsite disposal and wetlands restoration, which would constitute closure of Site 46 with minimal, post-closure care, is the selected remedial alternative. Based on available information and the current understanding of site conditions, Alternative 2 provides the best balance, with respect to the nine NCP evaluation criteria.

2.11.1 Summary of the Rationale for the Selected Remedy

Alternative 2, complete excavation with offsite disposal and wetlands restoration, is the selected remedy. By removing waste material and contaminated media, protection of ecological receptors from incidental ingestion and food chain contamination attributable to PAH-contaminated sediment and exposure to surface soil is achieved. Further, future impacts to surface water will be precluded. Lastly, construction of 1.2 acres of additional wetlands, versus 0.4 acres under Alternatives 3 and 4, fits into the overall site strategy by compensating for wetland losses resulting from remediation of Site 9.

Alternative 2 would be the most protective of all the alternatives, and would comply with applicable chemical-specific, location-specific, and action-specific ARARs because the contaminated soils, sediments, and source materials (i.e., wastes) would be removed from the site and sent to a permitted offsite facility for final disposal. Because groundwater would probably remain in contact with the waste material under Alternatives 3 and 4, these may not comply with applicable chemical-specific ARARs in the future, if groundwater contaminant levels were to increase from the 2000 sampling event levels. Alternative 2 is the easiest of all alternatives to implement and requires no long-term monitoring.

Based on information currently available, the Navy believes that Alternative 2 meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives, with respect to the balancing and modifying criteria. The Navy expects Alternative 2 to satisfy the following statutory requirements of CERLCA §121 (b):

- Protection of human health and the environment

- Compliance with applicable or relevant and appropriate Federal and Commonwealth of Virginia regulatory requirements

- Cost effectiveness. Although Alternative 2 is 38 percent more costly than the least expensive of the action alternatives, it gives the best value for short-term effectiveness, long-term effectiveness, and permanence.

- Use of permanent solutions and alternative treatment technologies to the maximum extent practicable. Alternative 2 utilizes permanent solutions. The remedy does not satisfy the statutory preference for treatment as a principal element of the remedy, because it is impracticable to treat the COCs in a cost-effective manner.

2.11.2 Description of the Selected Remedy

An area of about 66,100 square feet (including the adjacent marsh) will be excavated to remove existing landfill waste. The additional marsh area of excavation is approximately 21,100 square feet. Approximately 10,900 cubic yards of waste and contaminated soil/sediment will be excavated. The excavated materials will be transported to an appropriate offsite permitted landfill for final disposal. Following excavation, the disturbed areas will be backfilled, graded, and revegetated as needed. Existing wetland areas disturbed during construction will be restored as wetland areas. Along the west and southwest boundaries of Site 46, the remedial design would detail the establishment of grades, soil type(s), and vegetation to increase the wetland area by approximately 1.2 acres. The elevation of the new wetland area would range from an approximate elevation of 2 to 3 feet above mean sea level. Restoration of the existing marsh, disturbed during excavation activities, will also be conducted. Wetland hydrology and establishment will be monitored for a minimum of 5 years, during the spring and fall periods, with oversight provided by EPA. Corrective measures if needed to replace loss of vegetation from natural causes, such as drought, insects, and invasive plants would be implemented after agreement by the Navy, State, and EPA. Since all waste sources will be removed, long term monitoring is not required. Surface water will be sampled after the remedy is completed to measure the effectiveness of the remedy in reducing ecological risk in surface water. Surface water sampling may be done as part of the Gambo Creek Assessment or site specifically.

Performance Standards

The selected remedy shall achieve all Remedial Action Objectives provided in Table 2-26 within the boundaries of Site 46 and shall meet all ARARs and other applicable guidance. The following components of the selected remedy shall be evaluated as specific performance standards.

Excavation and Offsite Disposal

Approximately 10,900 cubic yards of waste and soil will be excavated and disposed offsite. Following excavation, confirmatory sampling of the bottom and side walls (for ecological Remedial Action Objectives) will be conducted to ensure that the mean of the residual level of each COPC does not exceed its respective Remedial Action Objective at a 95 percent upper confidence limit. The resultant volume of soil and waste material will be loaded onto trucks for offsite disposal.

Excavated material shall be disposed offsite at a permitted RCRA Subtitle D landfill; excavated soils will be characterized via laboratory analyses, including Toxicity Characteristic Leaching Procedure (TCLP). Should the soils fail regulatory limits established for TCLP, the corresponding areas will be handled as Resource Conservation and Recovery Act (RCRA) hazardous waste. Should the soils pass the TCLP regulatory limits, the soils will be disposed in a Subtitle D facility.

During excavation and backfilling operations, erosion and sedimentation controls shall be established to minimize impacts to downgradient areas of the site. Erosion and Sediment Control Regulations (4VAC 50-30-10 to 110) will be complied with during these activities.

Backfill

Backfilling shall be performed to the extent necessary to maintain and expand the proposed wetland area. Backfill material will consist of soils needed to support proposed wetlands and surrounding uplands vegetation.

Wetlands Restoration

Wetland areas disturbed during remedy implementation, as well as an additional area of approximately 1.2 acres, shall be planted with wetland species of plants and shrubs that are similar to those currently existing at the site. The restoration of wetlands at the site shall be conducted in accordance with the applicable portions of Erosion and Sediment Control Regulations (4VAC 50-30-10 to 110), Protection of Wetlands and Floodplains (E.O. 11990, 11998), Virginia Water Protection Permit Regulation (9 VAC 25-210-10 to 260), Wetlands Mitigation Compensation Policy (4 VAC 20-390-10 to 50), and relevant portions of the Clean Water Act (Sections 404 and 401).

Specifics of the excavation, backfilling, and restoration will be addressed in the detailed design. The actual quantities of excavated material will be determined during formal remedial design and as needed to implement the remedy.

2.11.3 Summary of the Estimated Remedy Costs

The estimated cost of the selected remedy includes $2,657,000 in capital costs for project planning, excavation, disposal, site and wetlands restoration, and reporting, as summarized in Table 2-29. Five years of 0 & M costs, as summarized in Table 2-30 would include $4,000 per year for wetlands inspection and vegetation replacement, if needed. A discount rate of seven percent was used to arrive at a present worth cost of $2,673,000, as summarized in Table 2-31.

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record File, an Explanation of Significant Differences (ESD), or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to –30 percent of the actual project cost.

2.11.4 Expected Outcomes of the Selected Remedy

The expected outcomes of implementing the selected remedy, in terms of land and resource uses and risk reduction, are as follows:

- Within approximately 6 months after remedial action contract award, waste and contaminated soils shall be removed from the site.

- Groundwater currently meets Federal primary drinking-water standards (MCLs) for contaminants associated with the site; it is anticipated that groundwater will continue to meet these standards following the remedial action.

- Concentrations of metals in surface water are expected to decrease to regional levels following remedy implementation. Surface water sampling is expected to confirm this outcome.

- An additional wetland area of approximately 1.2 acres is expected to be created to mitigate wetland loses due to remedial activities at Site 9.

TABLE 2-29

CONSTRUCTION COST ESTIMATE
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 1 OF 2

NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia
Site 46
Alternative 2: Complete Excavation, Off-Site Disposal & Wetland Restoration/Construction
Capital Cost

			Unit Cost				Total Cost				
Item	**Quantity**	**Unit**	**Subcontract**	**Material**	**Labor**	**Equipment**	**Subcontract**	**Material**	**Labor**	**Equipment**	**Total Direct Cost**
1 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
1.1 Office Trailer	5	mo	$205.50				$1,028	$0	$0	$0	$1,028
1.2 Storage Trailer (1)	5	mo	$85.00				$425	$0	$0	$0	$425
1.3 Construction Survey	1	ls	$3,500.00				$3,500	$0	$0	$0	$3,500
1.4 Equipment Mobilization/Demobilization	5	ea			$45.50	$229.00	$0	$0	$228	$1,145	$1,373
1.5 Site Utilities	5	mo	$2,000.00				$10,000	$0	$0	$0	$10.000
1.6 Clear and Grub Access Road	0.3	ac			$4,728.00	$3,861.00	$0	$0	$1,418	$1,158	$2,577
1.7 Grading for Access Road	950	sy			$1.24	$1.29	$0	$0	$1,178	$1,226	$2,404
1.8 Stabilization Fabric, 6 oz Polypropylene	950	sy		$0.84	$0.15	$0.04	$0	$798	$143	$38	$979
1.9 Gravel Access Road, 12" thick	950	sy		$2.70	$1.83	$0.33	$0	$2,565	$1,739	$314	$4,617
1.10 Remove Gravel from Road and Load	310	cy			$1.02	$0.75	$0	$0	$316	$233	$549
1.11 Haul/Dispose of Gravel On Station	310	cy			$2.34	$5.75	$0	$0	$725	$1,783	$2,508
1.12 Erosion Control, place & remove (super silt fence)	700	lf		$5.88	$9.28	$2.15	$0	$4,116	$6,496	$1,505	$12,117
1.13 Professional Oversight (5p * 5 days)	20	mwk			$4,000.00		$0	$0	$80,000	$0	$80,000
2 DECONTAMINATION											
2.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
2.2 Decontamination Trailer	5	mo	$2,250.00				$11,250	$0	$0	$0	$11,250
2.3 Decontamination Services (man-weeks)	20	wk		$840.00			$0	$16,800	$0	$0	$16,800
2.4 Decon Water	5000	gal	$0.20				$1,000	$0	$0	$0	$1,000
2.5 Decon Water Storage Tank, 6,000 gallon	5	mo	$600.00				$3,000	$0	$0	$0	$3,000
2.6 Clean Water Storage Tank, 4,000 gallon	5	mo	$540.00				$2,700	$0	$0	$0	$2,700
2.7 Disposal of Decon Waste (liquid & solid)	5	mo	$900.00				$4,500	$0	$0	$0	$4,500
2.8 PPE (5 p * 5 days * 20 weeks)	500	day		$30.00			$0	$15,000	$0	$0	$15,000
3 EXCAVATE/DEWATER MATERIAL											
3.1 Clear, Chip Brush & Trees (level D)	1.8	ac			$4,728.00	$3,861.00	$0	$0	$8,510	$6,950	$15,460
3.2 Construct Dewatering Pad (25' X 150')	3750	sf		$1.06	$0.16	$0.02	$0	$3,975	$600	$75	$4,650
3.3 Backhoe, 2 cy	70	day			$436.40	$1,017.00	$0	$0	$30,548	$71,190	$101,738
3.4 Dewater Excavation, 2 pumps	70	day			$80.00	$99.00	$0	$0	$5,600	$6,930	$12,530
3.5 On-site Dump Trucks, truck/days	140	day			$182.40	$447.25	$0	$0	$25,536	$62,615	$88,151
3.6 Loader, spread/mix on pad/load	70	day			$319.80	$400.80	$0	$0	$22,386	$28,056	$50,442
3.7 Confirmatory Sampling and Testing	18	ea	$300.00	$20.00	$50.00	$15.00	$5,400	$360	$900	$270	$6,930
3.8 UXO Oversight (8 hr/day * 70 days)	560	hr			$30.00		$0	$0	$16,800	$0	$16,800
4 OFF-SITE DISPOSAL											
4.1 Haul to Landfill	10690	cy	$18.00				$192,420	$0	$0	$0	$192,420
4.2 Dispose at Landfill	10690	cy	$43.00				$459,670	$0	$0	$0	$459,670
5 SITE RESTORATION											
5.1 Backfill Soil	2565	cy		$6.45	$0.24	$0.69	$0	$16,544	$616	$1,770	$18,930
5.2 Spread/Compact Soil	2565	cy			$0.44	$1.03	$0	$0	$1,129	$2,642	$3,771
5.3 Topsoil, 6" thick	1234	cy		$13.69	$0.32	$0.81	$0	$16,893	$395	$1,000	$18,288
5.4 Coastal Plain Seed Mix	7	msf		$26.13	$7.40	$7.85	$0	$183	$52	$55	$290
5.5 Erosion Control Matting, jute	150	sy		$0.62	$0.22	$0.08	$0	$93	$33	$12	$138
5.6 Wetland Vegetation	606	csf		$15.91	$8.65		$0	$9,641	$5,242	$0	$14,883
6 PROJECT DOCUMENTS/INSTITUTIONAL CONTROLS											
6.1 Prepare Documents & Plans including Permits	200	hr			$40.00		$0	$0	$8,000	$0	$8,000
6.2 Post Construction Documents	250	hr			$40.00		$0	$0	$10,000	$0	$10,000

TABLE 2-29

CONSTRUCTION COST ESTIMATE
SITE 46: JULY 28, 1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA
PAGE 2 OF 2

NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia
Site 46
Alternative 2: Complete Excavation, Off-Site Disposal & Wetland Restoration/Construction
Capital Cost

Item	Quantity	Unit	Unit Cost				Total Cost				Total Direct Cost
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Subtotal							$694,893	$92,769	$235,239	$189,664	$1,212,565
Local Area Adjustments							100.0%	106.1%	86.0%	86.0%	
Subtotal							$694,893	$98,428	$202,305	$163,111	$1,158,737
Overhead on Labor Cost @ 30%									$60,692		$60,692
G & A on Labor Cost @ 10%									$20,231		$20,231
G & A on Material Cost @ 10%								$9,843			$9,843
G & A on Subcontract Cost @ 10%							$69,489				$69,489
Total Direct Cost							$764,382	$108,271	$283,227	$163,111	$1,318,991
Indirects on Total Direct Cost @ 30%											$395,697
Profit on Total Direct Cost @ 10%											$131,899
Subtotal											$1,846,588
Health & Safety Monitoring @ 2%											$36,932
Total Field Cost											$1,883,520
Contingency on Total Field Cost @ 20%											$376,704
Engineering on Total Field Cost @ 10%											$188,352
TOTAL COST											**$2,448,575**

TABLE 2-30

OPERATION MAINTENANCE COST ESTIMATE
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia
Site 46
Alternative 2: Complete Excavation, Off-Site Disposal & Wetland Restoration/Construction
Annual Cost

Item	Cost per Year Years 1 thru 5	Notes
Wetland Inspection	$1,000	Inspect wetlands twice a year for 5 years
Wetland Replacement	$3,000	Replace wetland plants and grasses for 5 years
TOTALS	$4,000	

TABLE 2-31

TOTAL PRESENT WORTH COST ESTIMATE
SITE 46: JULY 28,1992, LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia
Site 46
Alternative 2: Complete Excavation, Off-Site Disposal & Wetland Restoration/Construction
Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,448,575		$2,448,575	1.000	$2,448,575
1		$4,000	$4,000	0.935	$3,740
2		$4,000	$4,000	0.873	$3,492
3		$4,000	$4,000	0.816	$3,264
4		$4,000	$4,000	0.763	$3,052
5		$4,000	$4,000	0.713	$2,852
				TOTAL PRESENT WORTH	**$2,464,975**

2.12 STATUTORY DETERMINATIONS

Remedial actions must meet the statutory requirements of Section 121 of CERCLA, as discussed below. Remedial actions undertaken at National Priority List (NPL) sites must achieve adequate protection of human health and the environment, comply with ARARs of both Federal and state laws and regulations, be cost-effective, and use, to the maximum extent practicable, permanent solutions and alternative treatment or resource recovery technologies. Also, remedial alternatives that reduce the volume, toxicity, and/or mobility of hazardous waste as the principal element are preferred. The following discussion summarizes statutory requirements that are met by the selected remedial alternative.

2.12.1 Protection of Human Health and the Environment

The selected remedy eliminates potential present and future risks to ecological and human receptors by removing the waste material and contaminated media.

2.12.2 Compliance with ARARs

The selected remedy will meet all identified ARARs/TBCs presented in Appendix D. The source of contamination (i.e., waste) and contaminated media will be removed from the site, providing for "clean" closure of the site. The remedy will comply with Safe Drinking Water MCLs that are applicable to groundwater at the site since current groundwater concentrations are already in compliance with these standards and the potential for future impact to the groundwater by leaching of soil contaminants will be minimized by removal of the contaminated soil. The selected remedy will comply with Virginia Water Quality Standards because the potential for future impact to surface water by erosion of contaminated surface soil will be minimized by the removal of contaminated soil. The selected remedy will also be conducted in compliance with the following action-specific ARARs:

- Commonwealth of Virginia Erosion and Sediment Control Regulations (4VAC 50-30-10 to 110) applicable to minimizing erosion of surface soil during excavation as well as during restoration.

- Commonwealth of Virginia Ambient Air Quality Standards (9VAC 50-30-260) applicable to control of dust emissions during excavation/backfilling of contaminated soil.

- Executive Order on Wetlands and Floodplains (E.O. 11990 and E. O. 11998), Virginia Water Protection Permit Regulation (9 VAC 25-210-10 to 260) applicable to wetlands restoration, and Wetlands Mitigation Compensation Policy (4 VAC 20-390-10 to 50).

- Clean Water Act (Sections 404 and 401) relevant portions that address placement of fill in wetlands.

A more detailed evaluation of ARARs is provided in Appendix D.

2.12.3 Cost Effectiveness

The selected remedy is cost-effective because it provides overall effectiveness proportional to the cost. The selected alternative would minimize short-term environmental impacts, provide long-term protection of human health and the environment, and meet all identified ARARs.

2.12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedy uses a permanent, long-term solution, because sources of contamination will be permanently removed from the site. Treatment of the landfills wastes is not practicable because of the heterogenous nature of the wastes.

2.12.5 Preference for Technologies That Reduce the Volume, Toxicity, and/or Mobility of Hazardous Waste Through Treatment as a Principal Element

None of the considered alternatives would reduce toxicity or the volume of waste through treatment, because no treatment is proposed. The selected remedy provides the highest degree of reduction in the mobility of contaminants present in the landfill, surface soils, and sediments, as they would be removed from the site and disposed of in a permitted landfill facility. Treatment of the landfills wastes is not practicable because of the heterogenous nature of the wastes.

2.12.6 Five-Year Review Requirements

Because this remedy will not result in hazardous substances, pollutants or contaminants remaining on-site above levels that allow for unlimited exposure and unrestricted use, a five-year review will not be required for this remedial action and allows unrestricted use of the site property in the future.

2.12.7 Documentation of Significant Changes

The selected remedy was the preferred alternative in the Proposed Remedial Action Plan and was presented at the public meeting held on July 24, 2001. Subsequent to the Proposed Plan, PRGs were refined and documented in a Technical Memorandum (September, 2001).

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3.0 RESPONSIVENESS SUMMARY

No written comments, concerns, or questions were received by the Navy, USEPA, or the Commonwealth of Virginia during the public comment period from July 20, 2001 to August 20, 2001. A public meeting was held on July 24, 2001 to present the Proposed Plan for Site 46 and to answer any questions on the Proposed Plan and on the documents in the information repositories. No questions were asked. A copy of the certified transcript from the public meeting is included in Appendix B.

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APPENDIX A

COMMONWEALTH OF VIRGINIA CONCURRENCE LETTER

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

Street address: 629 East Main Street Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 699-4500 TDD (804) 698-4021
http://www.deq.state.va.us

Dennis H. Treacy
Director

(804) 698-4000
1-800-592-5482

September 27, 2001

Mr. Abraham Ferdas, Division Director
Hazardous Site Cleanup Division (3HS00)
U.S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Re: Record of Decision for Site 46, Naval Surface Warfare Center, Dahlgren, VA

Dear Mr. Ferdas:

The Virginia Department of Environmental Quality staff has reviewed the Record of Decision (ROD) for Site 46 (Landfill A Stump Dump Road), at the Naval Surface Warfare Center, Dahlgren, Virginia. We concur with the selected remedial alternative as outlined in the ROD dated September 2001.

Should you have any questions concerning this letter, please feel free to contact Dave Gillispie at (804) 698-4209.

Very truly yours,

Erica S. Dameron

Erica S. Dameron
Director, Office of Remediation Programs

cc: Ryan Mayer, ChesDiv
Ann Swope, NSWC Dahlgren
Bruce Beach, EPA Region III
Karen Jackson Sismour, VDEQ
Jon Terry, VDEQ NRO
Durwood Willis, VDEQ
Dave Gillispie, VDEQ

APPENDIX B

CERTIFIED TRANSCRIPT OF PUBLIC MEETING

NAVAL SEA SYSTEMS COMMAND

NAVAL SURFACE WARFARE CENTER
DAHLGREN DIVISION

PUBLIC MEETING

TUESDAY, JULY 24, 2001, 7:00 P.M.
KING GEORGE COUNTY COURTHOUSE
KING GEORGE, VIRGINIA

PROPOSED REMEDIAL ACTION PLAN
Site 46, Landfill A, Stump Dump Road
Site 36, Depleted Uranium Mound, Pumpkin Neck
Site 49, Deleted Uranium Gun Butt

USEPA Region III
Hazardous Site Cleanup Division
Federal Facilities Section
Mr. Bruce Beach
1650 Arch Street, Philadelphia, Pennsylvania 18107

Virginia Department of Environmental Quality
Mr. David Gillispie
629 East Main Street, Richmond, Virginia 23219

Public Affairs Office
Commander, Naval Surface Warfare Center
Ms. Janice Miller
17320 Dahlgren Road, Mail Code CD06, Dahlgren, Virginia 22448

Reported by: Lola Gail Serrett

July 24, 2001, 7:22 p.m.:

MS. ANN SWOPE: I’d like to welcome everyone tonight to the public meeting for two proposed remedial action plans at the Naval Surface Warfare Center, Dahlgren, Virginia. The first is for Site 46, the July 28th, 1992, Landfill A, on Stump Dump Road. The second is for two sites: Site 36, the Depleted Uranium Mound at Pumpkin Neck for soil, and Site 49, the Depleted Uranium Gun Butt for both soil and groundwater. At this time, we will open public comment for these actions. If you have any comment whatsoever you’d like to express, please speak forward. If we don’t have any comments within a full minute, then we'll close the meeting. And you're free to send written comments to our Public Affairs Office, the Environmental Protection Agency in Philadelphia or the Virginia Department of Environmental Quality, and those addresses are on the back of your handouts.

So, at this time, I’d like to open the public meeting. If you have any questions, please raise your hand.

NOTE: No questions or comments from the audience.

MS. ANN SWOPE: One last call. Does anyone have any comment or questions to -- for public record? At this time then, I'll officially close the public comment period for Site 46, Site 36 and Site 49 at the Naval Surface Warfare Center, Dahlgren. Thank you.

HEARING CONCLUDED AT 7:24 P.M.

CERTIFICATE OF COURT REPORTER

I, Lola Gail Serrett, hereby certify that I was the Court Reporter at the Public Meeting held at King George Courthouse, King George, Virginia, on July 24, 2001, at the time of the meeting herein.

I further certify that the foregoing transcript is a true and accurate record of the proceeding herein.

Given under my hand this 25th day of July, 2001.

Lola Gail Serrett

LOLA GAIL SERRETT
Court Reporter

FILE: P072401L.HRG

APPENDIX C

TOXICITY PROFILES

TABLE OF CONTENTS

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1.0 ACENAPHTHENE

1.1 Noncancer Toxicity

Acenaphthene, also known as 1,2-dihydroacenaphthylene or 1,8-ethylenenaphthalene, is a tricyclic aromatic hydrocarbon that occurs in coal tar. It is used as a dye intermediate in the manufacture of some plastics and as an insecticide and fungicide. Acenaphthene has been detected in: cigarette smoke, automobile exhausts, and urban air; effluents from petrochemical, pesticide, and wood preservative industries; and soils, groundwater, and surface waters at hazardous waste sites. No absorption data are available for acenaphthene; however, by analogy to structurally-related polycyclic aromatic hydrocarbons (PAHs), it would be expected to be absorbed from the gastrointestinal tract and lungs. Although a large body of literature exists on the toxicity and carcinogenicity of PAHs, primarily benzo[a]pyrene, toxicity data for acenaphthene are limited. Acenaphthene is irritating to the skin and mucous membranes of humans and animals. Oral exposure of rats to daily 2-gram doses of acenaphthene for 32 days produced peripheral blood changes, mild liver and kidney damage, and pulmonary effects. Subchronic oral exposure to acenaphthene at doses of > 350 milligrams per kilogram (mg/kg) for 90 days produced increased liver weights, hepatocellular hypertrophy, and increased cholesterol levels in mice. Reproductive effects included decreased ovary weights and decreased ovarian and uterine activity, as well as smaller and fewer corpora lutea at 700 mg/kg/day. Adverse effects on the blood, lungs, and glandular tissues were reported in rats exposed daily to 12 milligrams per cubic meter (mg/m^3) of acenaphthene for five months. A reference dose (RfD) of 0.6 mg/kg/day for subchronic oral exposure and 0.06 mg/kg/day for chronic oral exposure to acenaphthene was calculated from a no-observed-adverse-effect level (NOAEL) of 175 mg/kg/day from a 90-day gavage study with mice. The critical effect was epatotoxicity. Data were insufficient to derive an inhalation reference concentration (RfC) for acenaphthene.

1.2 Carcinogenicity

No oral bioassays were available to assess the carcinogenicity of acenaphthene. A limited inhalation study, in which rats were exposed to 12 mg/m^3 acenaphthene for five months and observed for an additional eight months, provided no evidence of carcinogenicity. The U.S. Environmental Protection Agency (USEPA) has not assigned a weight-of-evidence classification for carcinogenicity to acenaphthene.

2.0 CARBAZOLE

Human exposure to carbazole occurs through the smoking of tobacco and the inhalation of polluted air. Workers may be exposed to carbazole and other anthracene derivatives via inhalation of vapors and dust and through dermal contact.

2.1 Noncancer Toxicity

No information is available concerning the noncarcinogenic health effects of carbazole.

2.2 Carcinogenicity

No data are available in humans. Limited evidence of carcinogenicity in animals. HEAST (USEPA, 1997) classified carbazole as a Class B2 carcinogen, based on the incidence of liver tumors in mice. The oral cancer slope factor (CSF) for carbazole is 0.02/(mg/kg/day).

3.0 DIBENZOFURAN

The general population may be exposed to dibenzofuran by inhalation and dermal contact from treated wood and through inhalation of air that has been contaminated by a variety of combustion sources (e.g., dibenzofuran has been identified in tobacco smoke). Exposure may also occur through consumption of contaminated food and drinking water. Occupational exposure to dibenzofuran may occur through inhalation and dermal contact, particularly at sites where coal tar and coal tar derivatives (especially creosote) are produced and used, including the handling of creosote-treated wood.

3.1 Noncancer Toxicity

No information is available concerning the chronic and subchronic health effects of dibenzofuran. The USEPA National Center for Environmental Assessment has issued an oral RfD of 0.004 mg/kg/day for dibenzofuran.

3.2 Carcinogenicity

This constituent is not classifiable as to human carcinogenicity based on lack of human and animal data for dibenzofuran alone.

4.0 FLUORENE

Human exposure to fluorene occurs primarily through the smoking of tobacco, inhalation of polluted air, and by ingestion of food and water contaminated by combustion effluents. In the USA, workers are potentially exposed to fluorene in smokehouses (facilities for smoke-curing of food) and in the paving, roofing, steel, aluminum, silicon carbide, and refractory brick industries.

4.1 Noncancer Toxicity

The USEPA has derived an oral noncarcinogenic RfD of 0.04 mg/kg/day, based on decreased red blood cell (RBC) packed cell volume and hemoglobin in a subchronic mouse study.

For 13 weeks, the mice were exposed to 0, 125, 250, or 500 mg/kg/day of fluorene suspended in corn oil. Parameters used to assess toxicity included food intake, body weight, clinical observations, hematology and serum chemistry, and gross and histopathological examinations. Increased salivation, hypoactivity, and urine-wet abdomens in males were observed in all treated animals. The percentage of mice exhibiting hypoactivity was dose-related. In mice exposed at 500 mg/kg/day, labored respiration, ptosis (drooping eyelids), and unkempt appearance were also observed. A significant decrease in RBC count and packed cell volume were observed in females treated with 250 mg/kg/day fluorene, and in both males and females treated with 500 mg/kg/day. Decreased hemoglobin concentrations and increased total serum bilirubin levels were also observed in the 500 mg/kg/day group. Decreases in erythrocyte count, packed cell volume, and hemoglobin concentrations were all observed at 125 mg/kg; however, these effects, although apparently dose-dependent, were not statistically significant. A significant decreasing trend in blood urea nitrogen and a significant increasing trend in total serum bilirubin were observed in both high-dose males and females. A dose-related increase in relative liver weight was observed in treated mice; a significant increase in absolute liver weight was also observed in the mice treated with 250 and 500 mg/kg/day fluorene. A significant increase in absolute and relative spleen and kidney weight was observed in males and females exposed to 500 mg/kg/day and in males at 250 mg/kg/day. Increases in the absolute and relative liver and spleen weights in the high-dose males and females were accompanied by histopathological increases in the amounts of hemosiderin in the spleen and in the Kupffer cells of the liver. No other histopathological lesions were observed (IRIS Online, September 2000).

4.2 Carcinogenicity

No fluorene data are available for humans, and there is inadequate evidence of carcinogenicity in animals. Therefore, fluorene is classified as Class D, not classifiable as to human carcinogenicity based on a lack of human data and inadequate data from animal bioassays.

5.0 IRON

5.1 Noncancer Toxicity

Iron is potentially toxic in all forms and by all routes of exposure. Inorganic iron is a poison by the intraperitoneal route. The inhalation of large amounts of iron dust may result in iron pneumoconiosis or arc welders lung. Chronic exposure to excess levels of iron (>50-100 mg iron/day) can result in a pathological deposition of iron in tissues. The target organs are the pancreas and liver.

Iron compounds are of varying toxicity. Iron oxides are a potential risk in all industrial settings. In general, ferrous compounds are more toxic than ferric compounds. Acute exposure to excessive levels of ferrous compounds can cause liver and kidney damage, altered respiratory rates, and convulsions. An oral RfD of 0.3 mg/kg/day has been published for iron by the USEPA, based on allowable intakes rather than on adverse effect levels. No inhalation RfD has been established for iron.

5.2 Carcinogenicity

Some iron compounds are suspected human carcinogens. Iron dust is an experimental neoplastigen and an increased incidence of lung cancer has been associated with exposure to iron dust. Iron oxide is an experimental tumorigen and a suspected human carcinogen. The USEPA has not published oral or inhalation slope factors for iron.

6.0 MANGANESE

6.1 Noncancer Toxicity

Manganese is nutritionally required in humans for normal growth and health. Humans exposed to approximately 0.8 mg of manganese/day in drinking water exhibited lethargy, mental disturbances (1/16 committed suicide), and other neurologic effects. The elderly appeared to be more sensitive than children. Oral treatment of laboratory rodents induced biochemical changes in the brain, but rodents did not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induced a generally typical spectrum of neurological effects and an increased incidence of pneumonia.

The USEPA has established an oral RfD of 0.02 mg/kg/day for manganese based on drinking water, and an oral RfD of 0.14 mg/kg/day based on food. The USEPA presented a verified chronic inhalation RfC based on a LOAEL for impairment of neurobehavioral function in occupationally exposed humans. The inhalation RfC is equivalent to 1.43E-5 mg/kg/day, assuming humans inhale 20 m^3 of air/day and weigh 70 kg. The central nervous system and respiratory tract are target organs of inhalation exposure to manganese.

6.2 Carcinogenicity

The USEPA classifies manganese in cancer weight-of-evidence Group D (i.e., manganese is not classifiable as to carcinogenicity to humans).

7.0 NAPTHALENE

Naphthalene, a white solid with a characteristic odor of mothballs, is a PAH composed of two fused benzene rings. The principal end use of naphthalene is as a raw material for the production of phthalic anhydride. It is also used as an intermediate for synthetic resins, celluloid, lampblack, smokeless powder, solvents, and lubricants. Naphthalene is used directly as a moth repellant, insecticide, anthelmintic, and intestinal antiseptic.

7.1 Noncancer Toxicity

Naphthalene can be absorbed by the oral, inhalation, and dermal routes of exposure and can cross the placenta in amounts sufficient to cause fetal toxicity. The most commonly observed effect of naphthalene toxicity following acute oral or inhalation exposure in humans is hemolytic anemia associated with decreased hemoglobin and hematocrit values, increased reticulocyte counts, the presence of Heinz bodies, and increased serum bilirubin levels. Hemolytic anemia has been observed in an infant dermally exposed to naphthalene and in infants whose mothers were exposed to naphthalene during pregnancy. Infants and individuals having a congenital deficiency of erythrocyte glucose-6-phosphate dehydrogenase are especially susceptible to naphthalene-induced hemolytic anemia. Acute oral and subchronic inhalation exposure of humans to naphthalene has resulted in neurotoxic effects (confusion, lethargy, listlessness, vertigo), gastrointestinal distress, hepatic effects (jaundice, hepatomegaly, elevated serum enzyme levels), renal effects, and ocular effects (cataracts, optical atrophy). Cataracts have been reported in individuals occupationally exposed to naphthalene and in rabbits and rats exposed orally to naphthalene. A number of deaths have been reported following intentional ingestion of naphthalene-containing mothballs. The estimated lethal dose of naphthalene is 5-15 grams for adults and 2-3 grams for children. Naphthalene is a primary skin irritant and is acutely irritating to the eyes of humans. Increased mortality, clinical signs of toxicity, kidney and thymus lesions, and signs of anemia were observed in rats treated by gavage with 400 mg/kg of naphthalene for 13 weeks. No adverse effects occurred at 50 mg/kg. Transient clinical signs of toxicity were seen in mice exposed by gavage to 53 mg/kg for 13 weeks. Subchronic oral exposure to 133 mg/kg/day for 90 days produced decreased spleen weights in female mice. Reduced numbers of pups/litter were observed when naphthalene was administered orally to pregnant mice. Negative results in a two-year feeding study with rats receiving 10-20 mg naphthalene/kg/day, and equivocal results in a mouse lung tumor bioassay suggest that naphthalene is not a potential carcinogen.

A chronic oral RfD of 2E-2 mg/kg/day for naphthalene has been calculated by USEPA. The inhalation RfD for chronic inhalation exposure to naphthalene is 9E-4 mg/kg/day.

7.2 Carcinogenicity

Available cancer bioassays were insufficient to assess the carcinogenicity of naphthalene. Therefore, USEPA has placed naphthalene in weight-of-evidence group D, not classifiable as to human carcinogenicity.

8.0 PHENANTHRENE

Phenanthrene is a PAH that can be derived from coal tar. Currently, there is no commercial production or use of this compound. Phenanthrene is ubiquitous in the environment as a product of incomplete combustion of fossil fuels and wood and has been identified in ambient air, surface and drinking water, and foods.

8.1 Noncancer Toxicity

Phenanthrene is absorbed following oral and dermal exposure. Data from structurally related PAHs suggest that phenanthrene would be absorbed from the lungs. Metabolites of phenanthrene identified in in vivo and in vitro studies indicate that metabolism proceeds by epoxidation at the 1-2, 3-4, and 9-10 carbons, with dihydrodiols as the primary metabolites. Although a large body of literature exists on the toxicity and carcinogenicity of PAHs, primarily benzo[a]pyrene, toxicity data for phenanthrene are very limited. No human data were available that addressed the toxicity of phenanthrene. Single intraperitoneal injections of phenanthrene produced slight hepatotoxicity in rats. Data regarding the subchronic, chronic, developmental, or reproductive toxicity in experimental animals by any route of exposure could not be located in the available literature. Data were insufficient to derive an oral RfD or inhalation RfC for phenanthrene. The chemical is not currently listed in IRIS or HEAST. The oral RfD for naphthalene is used as the RfD for phenanthrene for risk assessment purposes.

8.2 Carcinogenicity

No inhalation bioassays were available to assess the carcinogenicity of phenanthrene. A single oral dose of phenanthrene did not induce mammary tumors in rats and a single subcutaneous injection did not result in treatment-related increases in tumor incidence in mice. Neonate mice given intraperitoneal or subcutaneous injections of phenanthrene also did not develop tumors. No skin tumors were reported in two skin painting assays with mice. Phenanthrene was also tested in several mouse skin initiation-promotion assays. It was active as an initiator in one study, inactive as an initiator in four others, and inactive as a promoter in one study. Based on the lack of human data and inadequate data from animal bioassays, the USEPA has placed phenanthrene in weight-of-evidence group D, not classifiable as to human carcinogenicity.

SOURCES

The information contained in the Toxicological Profiles has been extracted from the following sources:

Agency for Toxic Substances and Disease Registry, ToxFAQs (Online), http://www.atsdr.cdc.gov.toxfaq.html, September 2000.

Hazardous Substance Date Base (HSDB), Online, http://toxnet.nlm.nih/gov/cgi/sis, September 2000.

USEPA, July 1997, Health Effects Assessment Summary Tables (HEAST).

U.S. Environmental Protection Agency (USEPA), Region IX, October 1999. “Region 9 Preliminary Remediation Goals (PRGs) 1999”, EPA Region IX, 75 Hawthorne Street, San Francisco, California, 94105.

U.S. Department of Energy, January 2000. Toxicity Profiles (Summary), Risk Assessment Information System (RAIS), Office of Environmental Management, Oak Ridge Operations (ORO), http://risk.lsd.ornl.gov/rap_hp.shtml.

U.S. Environmental Protection Agency (USEPA), Region III, April 2000. Risk-Based Concentration Table. EPA Region III, 841 Chestnut Street, Philadelphia, Pennsylvania 19107.

U.S. EPA (U.S. Environmental Protection Agency). September, 2000. Integrated Risk Information System (IRIS) - On-Line Database, http://www.epa.gov/ngispgm3/iris/subst/index.html.

APPENDIX D

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

APPENDIX D

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 46: JULY 28, 1992 LANDFILL A, STUMP DUMP ROAD
NSWCDL, DAHLGREN, VIRGINIA

ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
I. LOCATION SPECIFIC				
Endangered Species Act of 1978	16 USC §1531 50 CFR Part 402	Applicable	Act requires federal agencies to ensure that any action authorized by an agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat.	Potentially affected endangered species have not been identified. The remedial action will be implemented so resources are not adversely affected should any be identified in the future.
Virginia Endangered Species Regulations	4 VAC 15-20-130 to 140	Applicable	Similar Virginia requirements for submittal and review of environmental assessments.	
Rules and Regulations for the Enforcement of the Endangered Plant And Insect Species Act	2 VAC 5-320-10	Applicable		
The Archaeological and Historical Preservation Act of 1974	16 USC § 469	Applicable	Requires actions to avoid potential loss or destruction of significant scientific, historical, or archaeological data.	Site is not known to be within a historically significant area. If future resources are identified actions will be taken to ensure compliance.
Virginia Natural Area Preserves Act	Va. Code Ann. §§ 10.1-209 to 217	To Be Considered	Allows for preservation of certain significant ecological systems.	If specific species are found, actions will be taken to eliminate or minimize degradation to these resources.
Migratory Bird Area	16 USC §703	Applicable	Protects almost all species of native birds in the U.S. from unregulated "take" which can include poisoning at hazardous waste sites.	Remedy will be implemented to ensure that wastes have no impacts to native birds.

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APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
SITE 46: JULY 28, 1992 LANDFILL A, STUMP DUMP ROAD
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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
Chesapeake Bay Preservation Area Designation and Management Regulations	9 VAC 10-20-10 to 280	Relevant and Appropriate	Requires that certain locally designated tidal and non-tidal wetlands and other sensitive areas be subject to limitations regarding land-disturbing activities, removal of vegetation, use of impervious cover, erosion and sediment control, and stormwater management.	Remedy implementation will require construction activities. Actions will address the regulatory requirements.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 264.18 (b)	Applicable	Applies to treatment, storage, or disposal of hazardous waste within a 100 year floodplain area.	Remedy implementation may produce hazardous wastes within the 100 year floodplain area. Hazardous wastes, if encountered, will be managed consistent with Federal and Virginia requirements.
Virginia Water Protection Permit Regulation	9 VAC 25-210-10 to 260	Applicable	Facility or activity design must adequately address the issues arising from locating facilities in wetlands and delineated wellhead protection areas (determined vulnerable).	Remedy implementation will impact a wetland area. The remedy will minimize impacts to the wetlands and will restore wetlands areas on the facility.
Executive Order 11988, Protection of Floodplains	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	Federal agencies should avoid to the extent possible adverse impacts associated with the destruction or modification of floodplains.	Site is partially in the 100 year floodplain. Remedy will be installed in the floodplain and will be designed and constructed to minimize impacts to floodplain resources.

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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
Executive Order 11990, Protection of Wetlands Clean Water Act of 1972 (CWA) Section 404	40 CFR 6, Appendix A 33 USC §§ 1344	Applicable	Federal agencies should avoid to the extent possible adverse impacts associated with the destruction or modification of wetlands.	Portions of the site are characterized as wetlands. Remedy implementation will be designed and constructed to restore wetland impacts.
Wetlands Mitigation Compensation Policy	4 VAC 20-390-10 to 50	Applicable	The Federal agencies should request Va. Marine Resources Commission (VMRC) determine jurisdiction of the wetlands and applicable regulatory requirements.	The Navy will contact the VMRC concerning this project.

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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
II. ACTION SPECIFIC				
Virginia Solid Waste Management Regulations	9 VAC 20-80-10 to 790	Applicable	Prescribes the requirements for cleanup and corrective action for remediation of releases that have occurred as the result of improper management of solid wastes.	Solid wastes at Site 46, shall be handled under these regulations.
	Part IV. Management of Open Dumps and Unpermitted Facilities	Applicable	Requires the remedy to alleviate the conditions that may cause the facility to be classified as an open dump.	
Virginia Hazardous Waste Management Regulations	9 VAC 20-60-12 to 1505	Applicable	Applies to treatment, storage, or disposal of hazardous waste.	Hazardous wastes encountered will be managed consistent with Federal and Virginia requirements.
	9 VAC 20-60-261	Applicable	Provides that certain hazardous waste remaining in "empty" containers are not regulated as hazardous waste.	Rinseate from empty non-acutely toxic pesticide (such as DDT) containers are exempt.
EPA's Area of Contamination (AOC)Policy	Policy	To Be Considered	Allows hazardous waste to be managed within discrete areas without triggering hazardous waste regulatory requirements.	Waste generated on-site may be stored temporarily on-site prior to off-site disposal.
EPA's Contained-in Policy	Policy	To Be Considered	Allows the choice of appropriate health-based levels (for dieldrin) above which contaminated media must be handled as if it were a hazardous waste.	Contaminated soils at Site 46 do not contain listed hazardous waste and therefore are not automatically subject to LDRs. This policy applies to contaminated soils containing dieldrin.

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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
Regulations Governing the Transportation of Hazardous Materials	9 VAC 20-110-10 to 130	Applicable	Applies to transportation of hazardous waste.	Hazardous wastes, if encountered, will be managed consistent with Federal and Virginia requirements.
Military Munitions Rules	(40 CFR 260-266 and 270)	To Be Considered	Recently promulgated regulations in response to Section 107 of the Federal Facilities Compliance Act of 1992, identifying when conventional and chemical military munitions become hazardous waste. Applications of the rules are a 'TBC' until adopted by states authorized to administer RCRA.	Ordnance-related wastes potentially buried at Site 46 will be managed in compliance with the rules.
DoD Guidance on Property Contaminated with Ammunition, Explosives or Chemical Agents	DoD 6055.9-STD	To Be Considered	Dod guidance document stipulating policy and procedure to provide protection of personnel resulting from DoD ammunition, explosives or chemical agent contamination. Includes property currently or formerly owned, leased or used by DoD, and calls for identification and control at active installations, and provides guidance for potential land disposal.	Excavation of Site 46 will be completed to be consistent with DoD policy and procedures to address safety issues should UXO issues arise.
Erosion and Sediment Control Regulations	4 VAC 50-30-10 to 110	Applicable	Erosion and sediment control plans are to be submitted for land-disturbing activities, and be in compliance with of the locality and/or local soil and water conservation district.	Construction activities will disturb the land in the vicinity of the site. Activities will address Virginia erosion and sediment control requirements.

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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
AIR				
Ambient Air Qualtiy Standards	9 VAC 5-30-10 to 80			
Visible and Fugitive Dust Emissions	9 VAC 5-30-20	Applicable	Control of Particulate Matter (TSP)	Visible and Fugitive Dust emissions from remedial actions shall be controlled, as necessary.
	9 VAC 5-30-60	Applicable	Control of Particulate Matter (PM10)	
	9 VAC 5-50-60 to 120	Applicable	Standards for visible and/or fugitive dust emissions.	
Standards of Performance for Toxic Pollutants	9 VAC 5-50-160 to 230	Applicable	Standards of performance for toxic pollutants.	Toxic pollutants are not expected during remedial actions; however, corrective action will be performed if problems arise.
WATER				
Criteria for Classification of Solid Waste Disposal Facilities and Practices	49 CFR 257.3-3(a) 33 USC §§ 1288 & 1342	Potentially Applicable	A facility shall not cause a discharge of pollutants into the waters of the U. S. that is in violation of the substantive requirements of the NPDES under CWA Section 402, as amended.	No discharges under the remedy are planned. In addition, NPDES program is delegated to Virginia (VPDES). Potentially applicable for situations potentially not covered by VPDES.
Water Quality Standards	9 VAC 25-260-5 to 550	Applicable	Standards and criteria for State waters, including wetlands.	Provides standards for evaluating State waters and wetlands at Site 46.

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ARAR or TBC	Statute or Regulation	Classification	Requirement Synopsis	Applicability to Remedial Alternatives
Virginia Pollutant Discharge Elimination System (VPDES) Virginia Pollution Abatement (VPA) Permit Regulation	9 VAC 25-31-10 to 940 9 VAC 25-32-10 to 300	Applicable Applicable	Procedures and requirements for discharging and pollutants into surface waters, or any activity which impacts physical, chemical or biological properties of surface waters.	Excavation, backfilling and regrading Site 46 not expected to produce waste liquids that would be discharged to surface waters.
Stormwater Management Regulations	4 VAC 3-20-10 to 251	Applicable	Criteria for Stormwater Management.	Excavation, backfilling, and regrading of Site 46 will include applicable stormwater management requirements.